Installation Restoration Program
Final 1999-2000 Groundwater Monitoring Work Plan

143rd Combat Communications Squadron
Seattle Air National Guard Station
Washington Air National Guard
Seattle, Washington

September 1999

Air National Guard
Andrews AFB, Maryland

113_001
KCSlip4 41501

SEA408031

Installation Restoration Program
Final 1999-2000 Groundwater Monitoring Work Plan

143rd Combat Communications Squadron
Seattle Air National Guard Station
Washington Air National Guard
Seattle, Washington

September 1999

Prepared For:

Air National Guard
Andrews AFB, Maryland

Prepared By:

ERM

Enviromental Resources Management
915 118th Avenuew SE, Suite 130
Bellevue, Washington 98005

KCSlip4 41502

SEA408032

TABLE OF CONTENTS

SEA408033

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

KCSlip4 41506

SEA408036

LIST OF FIGURES

KCSlip4 41507

SEA408037

LIST OF TABLES

KCSlip4 41508

SEA408038

LIST OF ACRONYMS/ABBREVIATIONS

Acronym/ Abbreviation	Definition
ANG	Air National Guard
ANG/CEVR	Air National Guard/ Installation Restoration Program Branch
ANGS	Air National Guard Station
AOC	Area of concern
ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
bgs	Below ground surface
Boeing	The Boeing Company
CCSQ	Combat Communications Squadron
ERM	Environmental Resources Management
°F	Degrees Fahrenheit
IDW	Investigation-derived waste
IRP	Installation Restoration Program
MTCA	Model Toxics Control Act
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Inspection
PCE	Tetrachloroethene
pCi/g	PicoCuries per gram
PSG	Project screening goal
QA/QC	Quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SSHP	Site Safety and Health Plan
TCE	Trichloroethene
µg/l	Micrograms per liter
USEPA	United States Environmental Protection Agency
VOA	Volatile organics analysis
VOC	Volatile organic compound
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology

SECTION 1.0

INTRODUCTION

Environmental Resources Management (ERM) has prepared this 1999-2000 Groundwater Monitoring Work Plan in support of the planned groundwater monitoring at the 143rd Combat Communications Squadron (CCSQ), Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington (Figure 1-1). This work is being conducted as part of the Air National Guard (ANG) Installation Restoration Program (IRP) under Contract DAHA90-94-D-0014, Delivery Order 0067, between ERM and the National Guard Bureau (NGB), Departments of the Army and the Air Force. The Air National Guard/Installation Restoration Program Branch (ANG/CEVR) is providing technical and project management oversight for this investigation on behalf of the ANG. The purpose of this Groundwater Monitoring Work Plan is to describe the elements and procedures of the planned 1999-2000 groundwater monitoring program at the Seattle ANGS.

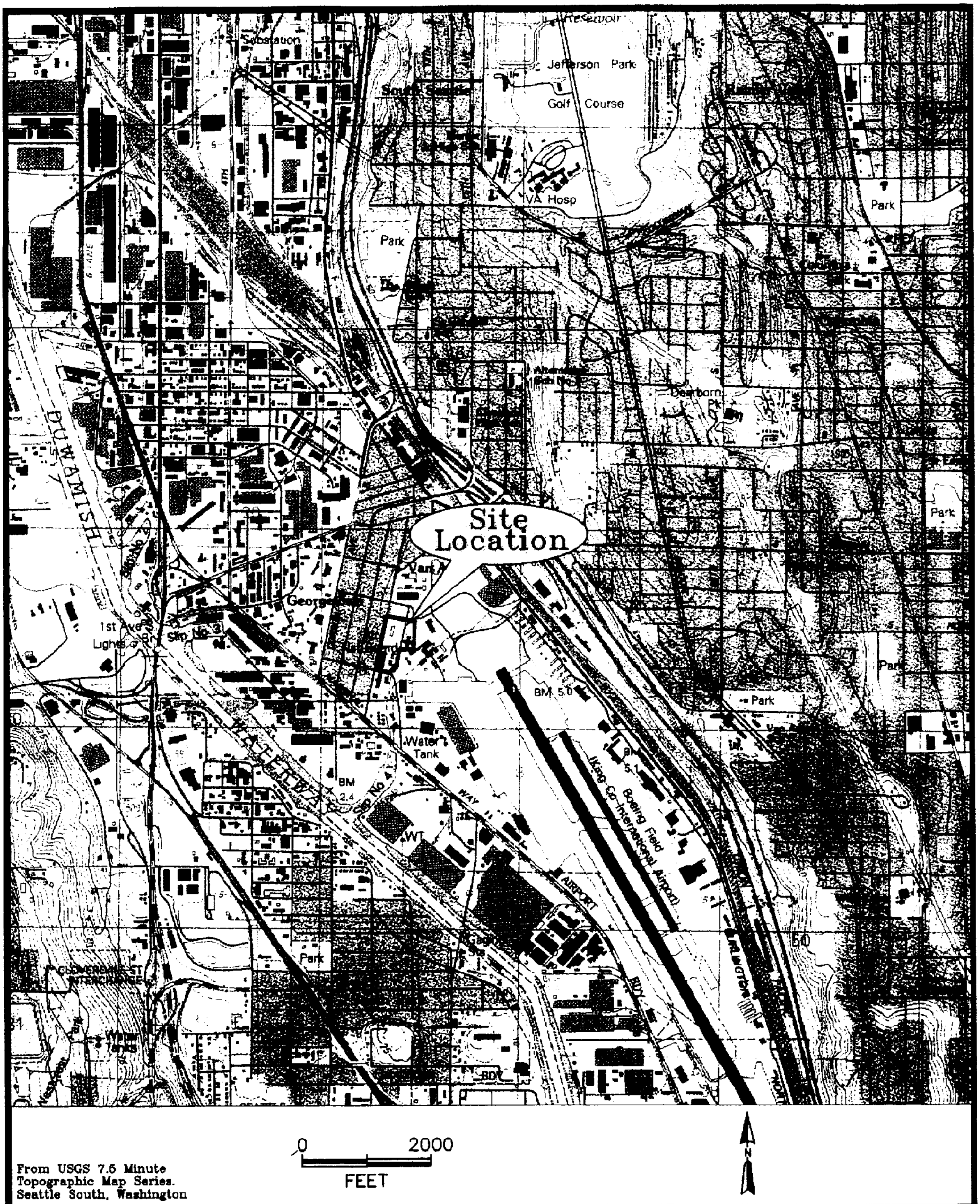
A Phase I Remedial Investigation (RI) was completed at the Seattle ANGS in 1997, and a Phase II RI was completed in 1999. The Phase I and II RI results are reported in ERM (1998) and ERM (1999), respectively.

1.1 Project Objectives and Scope

The purpose of the 1999-2000 groundwater monitoring program is to supplement the RI phases with additional data needed to evaluate remedial options for groundwater contamination previously identified at the Station. The monitoring program will include quarterly sampling of existing groundwater monitoring wells at the Station for 1 year.

KCSlip4 41510

SEA408040



From USGS 7.5 Minute Topographic Map Series. Seattle South, Washington

FIGURE 1-1

LOCATION MAP OF SEATTLE AIR NATIONAL GUARD STATION SEATTLE, WASHINGTON
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

S:\CAD\DWGS\6032\41\60324115

KCSlip4 41511

SEA408041

1.2 Work Plan Structure

This 1999-2000 Groundwater Monitoring Work Plan provides a description of the activities for the monitoring program and is organized into 12 sections and two appendices. The contents of the sections are as follows:

- Section 1.0 provides general introductory information for the monitoring program;
- Section 2.0 describes the project management approach for the monitoring program;
- Section 3.0 provides background information for the Seattle ANGS;
- Section 4.0 describes the environmental setting for the vicinity of the Seattle ANGS;
- Section 5.0 describes the permits required for the monitoring program;
- Section 6.0 outlines the monitoring program investigative approach;
- Section 7.0 describes the field investigation procedures;
- Section 8.0 describes sample collection procedures;
- Section 9.0 describes equipment decontamination procedures;
- Section 10.0 describes investigation-derived waste (IDW) management;
- Section 11.0 outlines the project schedule and deliverables; and
- Section 12.0 lists the references cited in this Work Plan.

The following appendices are included in this Work Plan:

- Appendix A contains the Sitewide Safety and Health Plan (SSHP); and
- Appendix B contains the Quality Assurance Project Plan (QAPP).

KCSlip4 41512

SEA408042

SECTION 2.0

PROJECT MANAGEMENT APPROACH/PLAN

This section provides an overview of ERM's project management plan for the 1999-2000 groundwater monitoring program.

2.1 Project Management Organization

The project will be managed and executed by personnel who will ensure that the objectives of the groundwater monitoring program are met. Analytical testing services will be provided by an experienced subcontractor firm that possesses the required permits, licenses, and accreditation necessary to work in the State of Washington.

ERM's project team will consist of the following key positions:

Program Manager: Responsible for the overall execution of the project and for maintaining an open line of communication with the ANG/CEVR and the local ANG Environmental Coordinator.

Project Manager: Supervises the project team, provides technical direction and interface with the ANG Project Manager and the ANG Environmental Coordinator, coordinates subcontractor support, and manages project schedule and budget.

Site Manager: Directly supervises the on-site field investigation activities and project team, and provides technical direction and interface with the Project Manager.

Quality Assurance/Quality Control (QA/QC) Manager: Responsible for establishing standardized quality assurance procedures for the project and for ensuring that effective procedures and controls are implemented to achieve project quality goals and adherence to contract requirements.

Site Safety and Health Officer: Responsible for ensuring that physical and chemical hazards are appropriately mitigated through effective execution of the SSHP.

KCSlip4 41513

SEA408043

Project Scientists and Engineers: Includes qualified geologists, chemists, toxicologists, and engineers.

2.2 Project Procedures

An open line of communication will be maintained between the Project Manager and the project team to ensure that project objectives are met. Sampling and other field activities will be carried out in accordance with this Work Plan. The 1999-2000 groundwater monitoring program will be executed according to the project schedule included in Section 11.0 of this Work Plan.

2.3 Quality Management

The QA/QC Manager will be responsible for ensuring that established QA/QC procedures are followed. Immediate corrective actions will be taken when they are deemed necessary. The QA/QC procedures will be directed in accordance with the Seattle ANGS Quality Assurance Project Plan (QAPP) prepared for the Remedial Investigation/Feasibility Study (RI/FS) phase of the IRP (Appendix B).

2.4 Subcontract Management

ERM is responsible for performance of the work under this contract delivery order, including the work of subcontractors. ERM will hire a subcontractor for analytical testing services. The Project Manager will maintain oversight of the subcontractor's completion of specified tasks with respect to technical performance, quality, and adherence to cost and schedule. In addition, ERM will ensure that subcontractor activities comply with the QAPP.

2.5 Project Staffing

ERM will use an experienced team of professionals who have performed similar work at the Seattle ANGS or other investigation sites. The project team will be selected by the ERM Program Manager and Project Manager.

KCSlip4 41514

SEA408044

SECTION 3.0

INSTALLATION BACKGROUND INFORMATION

This section provides background information for the Seattle ANGS. Information presented in this section was derived primarily from the Phase II RI Report (ERM 1999a).

3.1 Site Location

The Seattle ANGS is at 6736 Ellis Avenue South in Seattle, Washington, and occupies approximately 7.5 acres near the north end of the King County International Airport (Boeing Field). A map of the Seattle ANGS is shown on Figure 3-1.

3.2 Installation Type and Operational Status

This section summarizes the activities and history of the Seattle ANGS.

3.2.1 Installation Type

The Seattle ANGS is currently the home of the 143rd CCSQ. The current mission of the 143rd CCSQ is to provide mobile communication equipment and support for airports and airfields. The facility currently employs approximately 129 personnel, of which 25 are full-time employees.

3.2.2 Site History

The Seattle ANGS was built during World War II by the War Department and was used by the United States Army Air Corps as the "Aircraft Factory School." In 1948 the property was given to King County as surplus property and was subsequently leased to the Washington ANG.

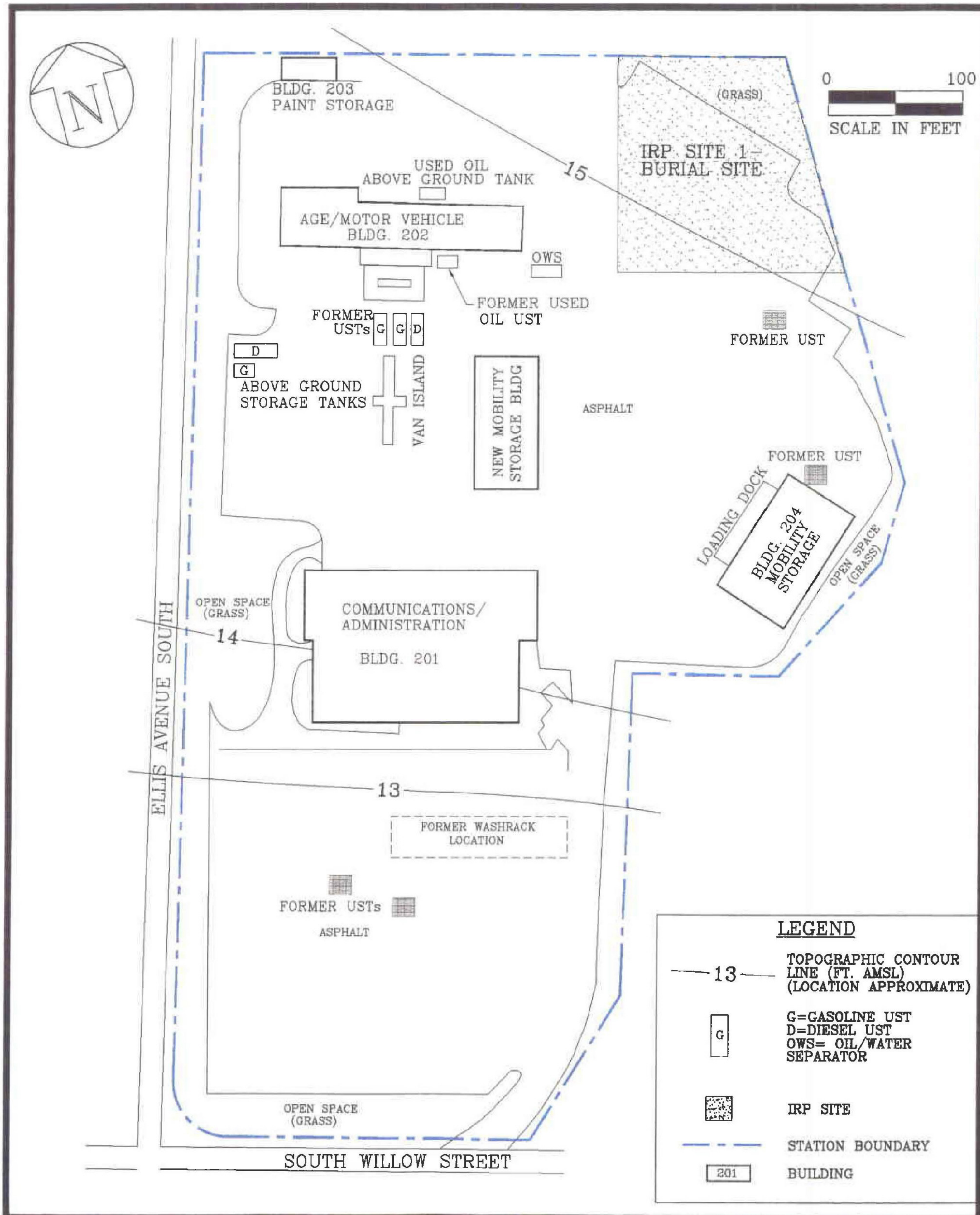


FIGURE 3-1

S:\cad\dwgs\6051\41\60514101

SITE MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

KCSlip441516

SEA408046

On 21 April 1948, the 143rd Aircraft Control and Warning Squadron was established on the site. From May 1951 to February 1953, the 143rd was activated for recruitment purposes. During this period the unit had two C-47 aircraft. In 1960 the name of the unit was formally changed to the 143rd Communications Squadron Tributary Teams. In 1969 and 1988 the name of the unit was again changed, becoming the 143rd Mobile Communications Squadron and the 143rd CCSQ, respectively.

Currently, the Seattle ANGS property is leased from King County by the United States Air Force, which in turn licenses the property to the Washington State Military Department for ANG use.

3.3 Site Structures

In 1948 the Station consisted of 17 acres of land, including an aircraft parking ramp, leased from King County. At that time the property contained 15 buildings, all of which were subsequently demolished. In 1951 a new property lease decreased the size of the Station from 17 acres to 7.5 acres. Buildings were constructed for headquarters, a mess hall, warehouses, and vehicle service requirements. In 1980 the NGB approved a Congress-funded replacement of all buildings. The buildings were completed in 1984 with the exception of Building 204 (Mobility Storage), which was completed in 1988, and the new Mobility Storage Building, which was completed in 1998.

The Seattle ANGS currently consists of 7.5 acres and five buildings (Figure 3-1). Other site features include miscellaneous aboveground storage tanks, a van island, and an oil/water separator. The Station used to have a washrack and several underground storage tanks; the washrack and the underground storage tanks are no longer present at the site.

3.4 Surrounding Land Use

Land use adjacent to the Seattle ANGS and sites of potential environmental concern are shown on Figure 3-2. Adjacent properties to the north, south, and east of the Station are zoned for general industrial use, are currently used for industrial purposes, and have a history of industrial use. The properties directly south and east of the Station are owned by the Boeing Company (Boeing) or leased by Boeing from King

KCSlip4 41517

SEA408047

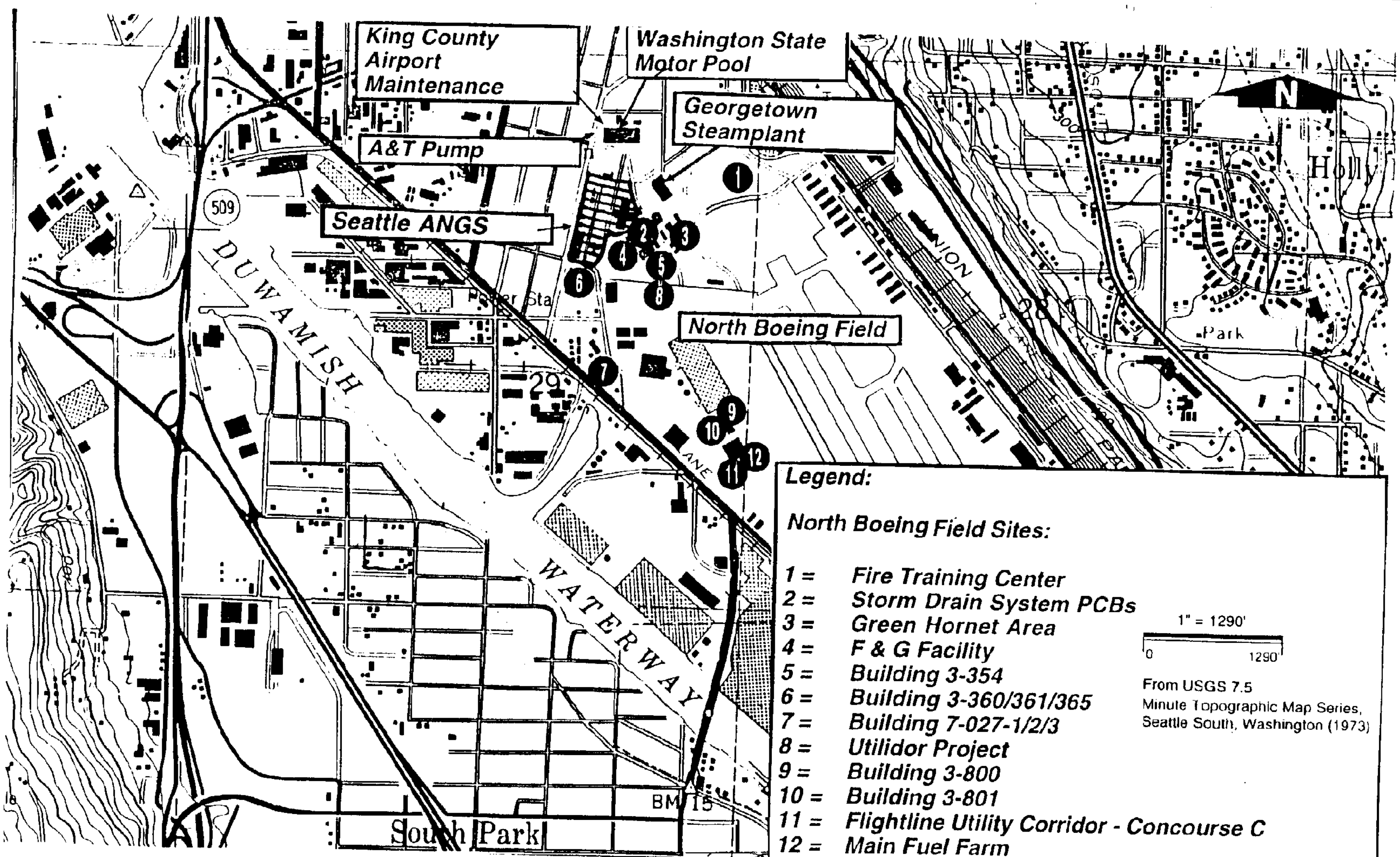


FIGURE 3-2

s:\cad\dwgs\6051\41\60514102

ADJACENT LAND USE AND
SITES OF ENVIRONMENTAL CONCERN

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

FINAL

KCSlip4 41518
SEA408048

County. Immediately north of the Station are several trucking companies and a Washington State Motor Pool auto maintenance facility. The area west of the Station, across Ellis Avenue South, consists of residential properties. The sites of potential environmental concern shown of Figure 3-2 are discussed further in the Phase II RI Report (ERM 1999a).

3.5 Previous Remedial Actions

Three IRP investigations have been conducted at the Seattle ANGS:

- A Preliminary Assessment (PA) was conducted by the ANG in December 1993.
- A Preliminary Assessment/Site Inspection (PA/SI) was conducted by Operational Technologies Corporation (OpTech) in 1994 (OpTech 1995).
- A two-part RI was conducted by ERM between 1996 and 1999 (ERM 1998, 1999a).

In addition, a Feasibility Study has been completed (ERM 1999b). The objectives and scope of the three IRP investigations are summarized below.

3.5.1 Preliminary Assessment

The PA focused on the identification and evaluation of historic and current use, handling, and disposal practices of hazardous materials and hazardous waste at the Seattle ANGS. Based on the results of the PA, one area of concern (subsequently designated IRP Site 1- Burial Site) was identified as being potentially contaminated with hazardous materials and/or waste, thus warranting further IRP investigation.

3.5.2 Preliminary Assessment/Site Inspection

The objective of the PA/SI was to identify IRP sites and to confirm the presence or absence of soil and groundwater contamination associated with past hazardous material and hazardous waste handling and disposal practices. Field activities for the PA/SI included screening and confirmation activities. The screening activities included a soil vapor survey, a ground-penetrating radar survey, and a magnetometer survey at the IRP site. Confirmation activities included the collection of soil samples from three soil borings and one monitoring well boring, and the installation and sampling of three groundwater monitoring wells.

3.5.3 Remedial Investigation

The objective of the RI was to determine the nature and extent of contamination associated with the IRP site. The RI was conducted in two phases. Field activities for the Phase I RI included screening and confirmation activities. The screening activities included organic vapor screening and TPH (Total petroleum hydrocarbons) screening of soil samples. Confirmation activities included the collection and analysis of 22 direct-push groundwater samples, 10 surface soil samples, two storm sewer catch basin samples, and subsurface soil samples from 11 soil borings. Additional Phase I RI activities included the installation of five groundwater monitoring wells, quarterly sampling of the RI and PA/SI monitoring wells for 1 year, and aquifer slug testing to estimate hydraulic conductivity.

Field activities for the Phase II RI included soil vapor sampling at 40 locations across the site, direct-push soil and groundwater sampling at 20 locations, installation of five groundwater monitoring wells, and quarterly groundwater monitoring for 1 year.

The RI sampling locations are shown on Figures 3-3 through 3-6; the RI sampling program is summarized on Tables 3-1 and 3-2. Complete analytical testing results and interpretation of the RI data are presented in the Phase I and II RI Reports (ERM 1998; ERM 1999a).

3.6 Source, Nature, and Extent of Contamination

Numeric project screening goals (PSGs) were developed during the RI for use in identifying contaminants of concern (COCs) in soil and groundwater. The PSGs were derived from chemical-specific State and Federal applicable or relevant and appropriate requirements (ARARs). The derivation of PSGs and the screening process used to identify COCs are described in the Phase II RI Report (ERM 1999a).

Two chlorinated volatile organic compounds (VOCs), tricloroethene (TCE) and tetrachloroethene (PCE), have been detected in groundwater at

KCSlip4 41520

SEA408050

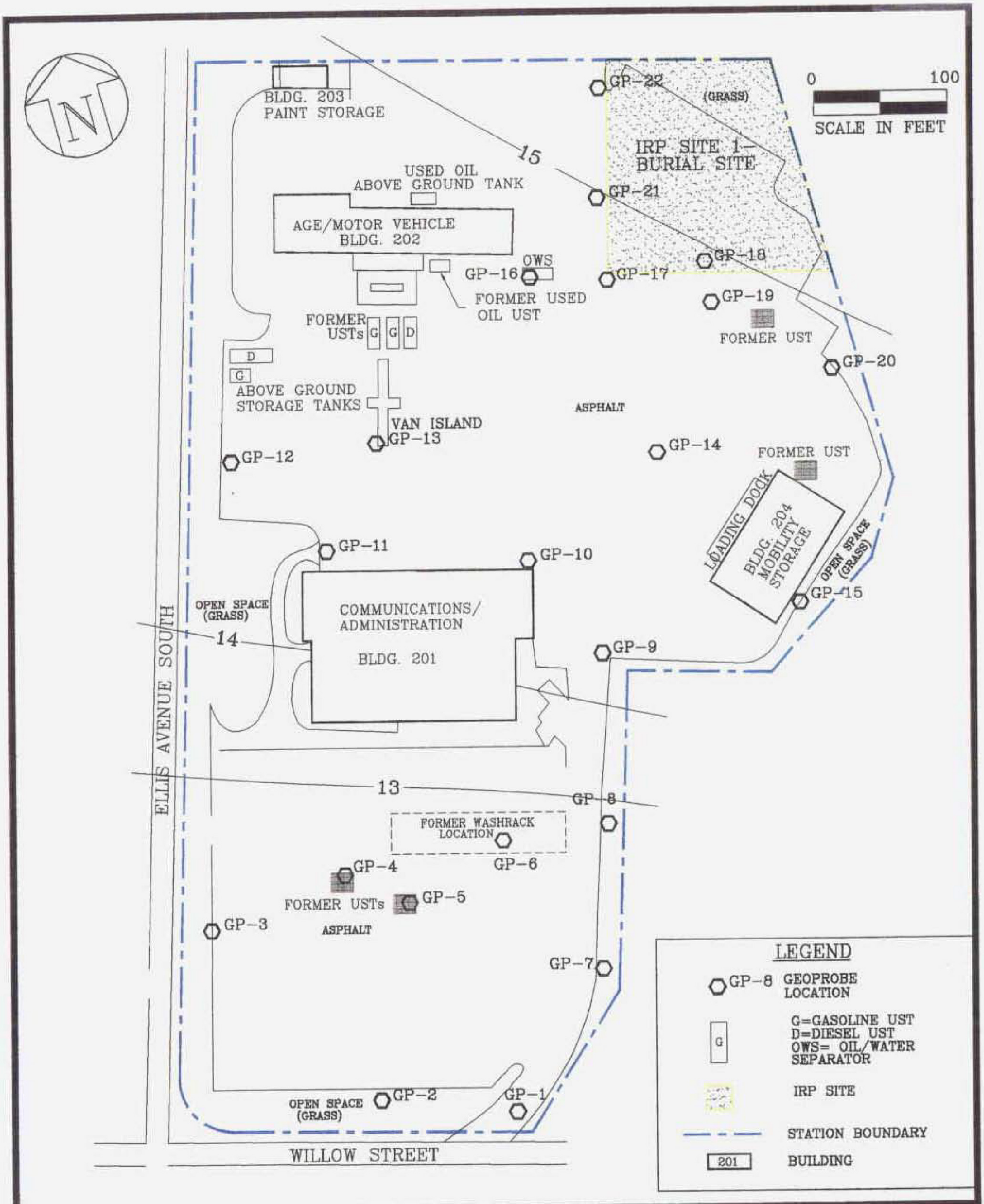


FIGURE 3-3

PHASE I RI GEOPROBE
GROUNDWATER SAMPLING LOCATIONS
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

G:\\6067\21\60672102.dwg

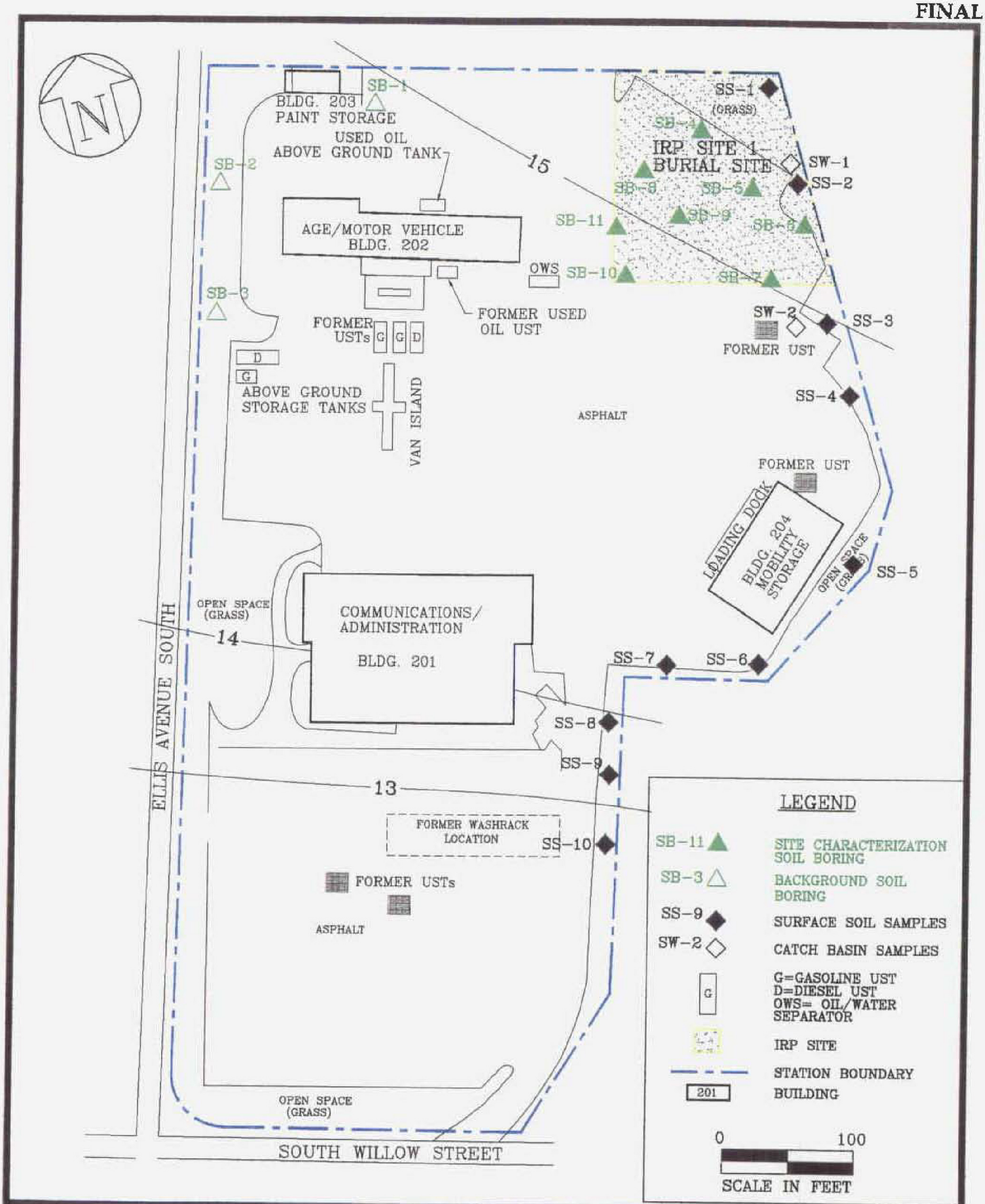


FIGURE 3-4

PHASE I RI SOIL SAMPLING
LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

G:\\6067\21\60672103.dwg

KCSlip441522

SEA408052

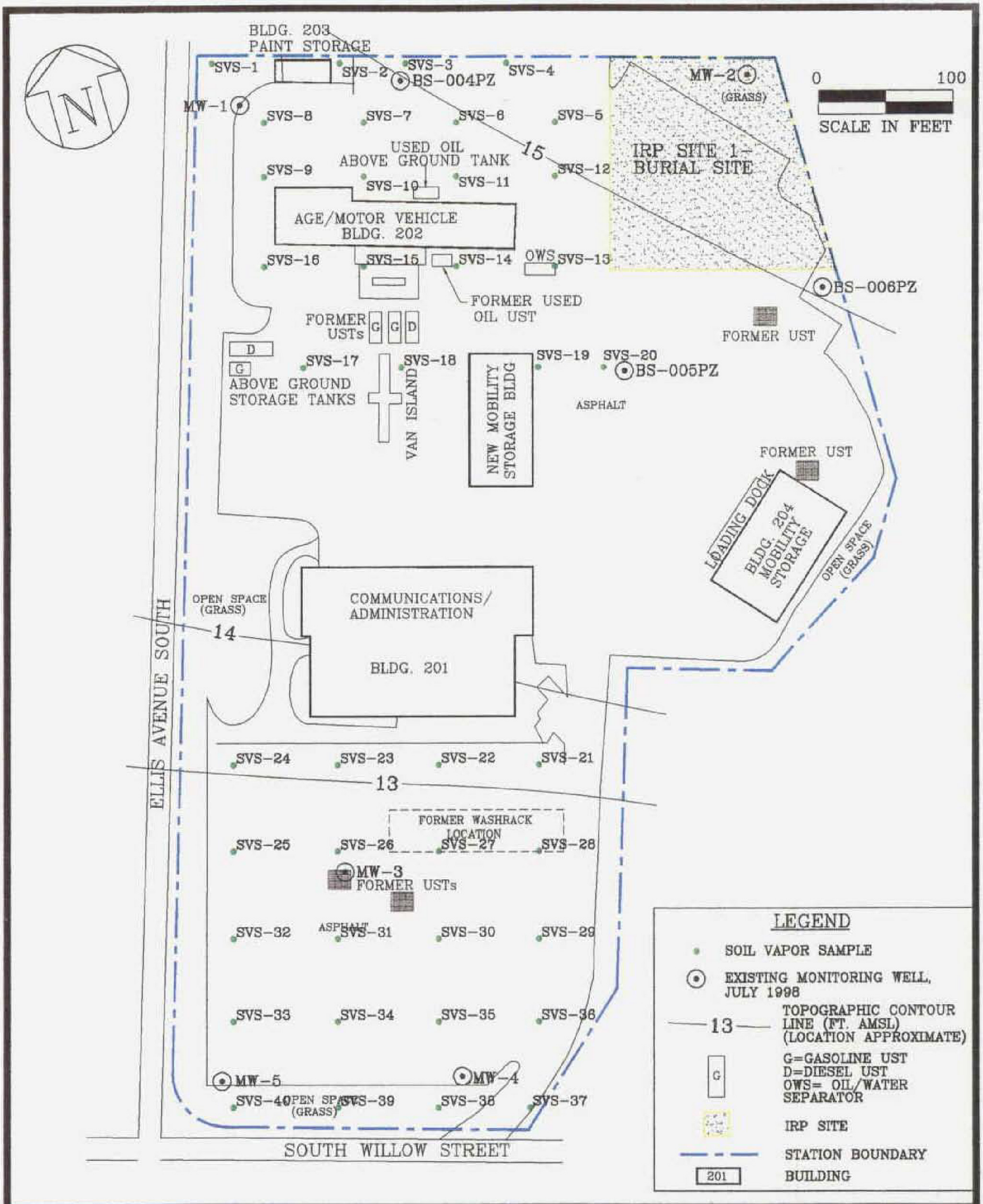


FIGURE 3-5

PHASE II RI SOIL VAPOR
SAMPLING LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

G:\\6067\21\60672104.dwg

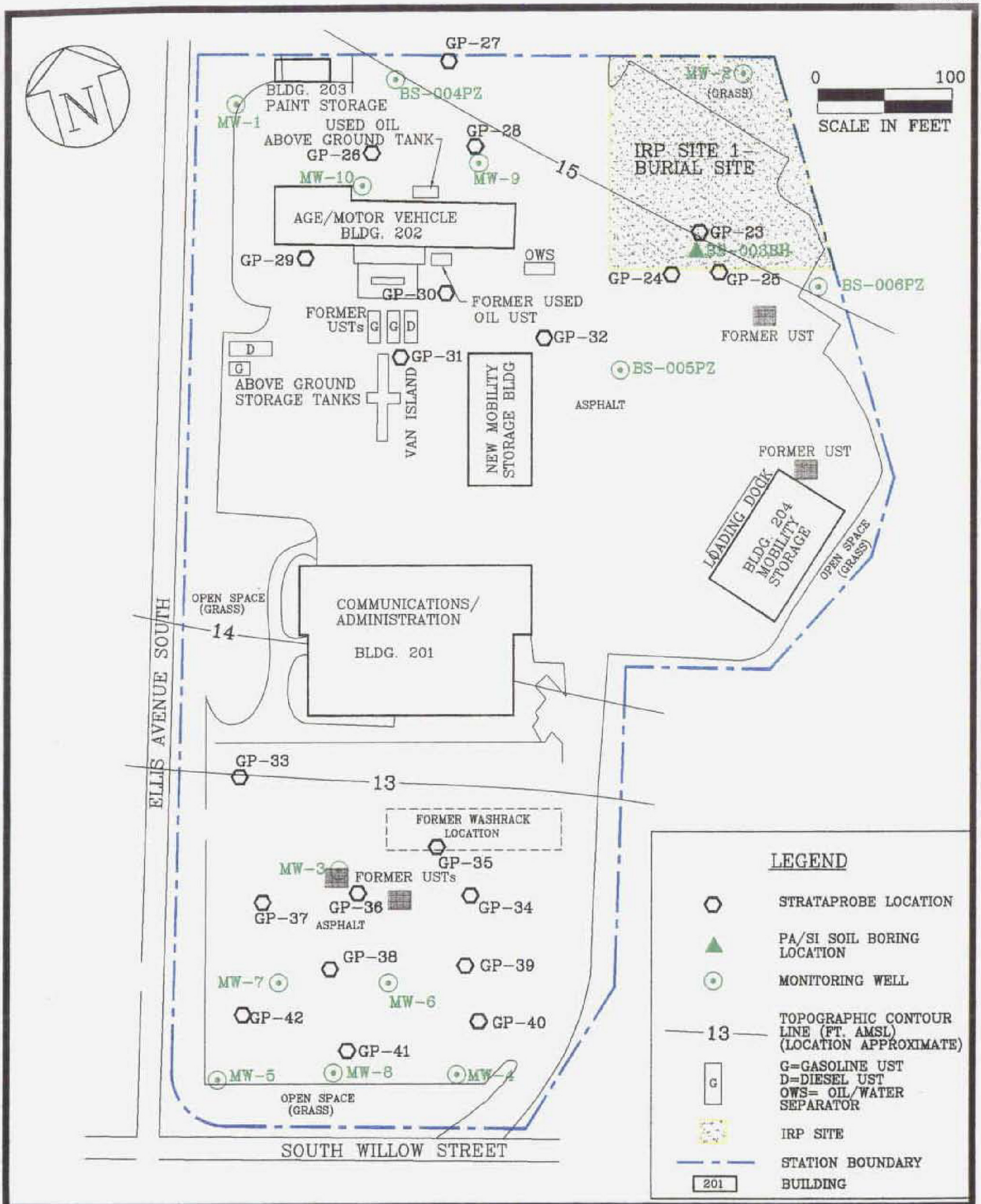


FIGURE 3-6

PHASE II RI SOIL AND GROUNDWATER SAMPLING LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

g:\\6067\21\60672105.DWG

KCSlip441524

SEA408054

TABLE 3-1

Phase I Remedial Investigation Sampling Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Site	Matrix	Sampling Method	Field Parameters	Lab Parameters	USEPA Method	Primary Samples	QA/QC Samples					Matrix Total*
							Trip Blank	Rinsate Blank	Field Blank	Field Duplicate	MS/MSD	
Background	Subsurface Soil 3 Locations	Soil Borings	Soil headspace screening using PID/field TPH	PP Metals	3050/6010/6020/7470	9		1		1		10
			Soil Classification	SVOCs	3550/8270	9		1		1		10
				TPH	WTPH-HCID (1)	9		1		1		10
				Radionuclides	SM-7110A/B, 903.1, 904.0	9		1		1		10
	Groundwater 1 RI MW 1 PA/SI MW	Monitoring Wells (per round)	Temperature	PP Metals	6010/6020/7470	2						2
			pH	VOCs	5030/8260	2	1					2
			Specific conductance	SVOCs	3550/8270	2						2
			Turbidity	TPH	WTPH-HCID (1)	2						2
				Radionuclides	SM-7110A/B, 903.1, 904.0	2						2
IRP Site No.1	Subsurface Soil 9 Locations	Soil Borings, MW Boring MW-3	Soil headspace screening using PID/field TPH	PP Metals	3050/6010/6020/7470	16		1	1	1	2	19
			Soil Classification	TPH	WTPH-HCID (1)	16		1	1	1	2	19
				VOCs	5030/8260	2						2
				SVOCs	3550/8270	16		1	1	1	2	19
				Radionuclides	SM-7110A/B, 903.1, 904.0	16		1	1	1	2	19
	Storm Sewer Catch Basin Sediments 2 Locations	Grab Samples	Headspace screening using PID/field TPH	PP Metals	3050/6010/6020/7470	2						2
				TPH	WTPH-HCID (1)	2						2
				SVOCs	3550/8270	2						2
				VOCs	5030/8260	2						2
				Radionuclides	SM-7110A/B, 903.1, 904.0	2						2

KCSlip4 41525

SEA408055

TABLE 3-1

Phase I Remedial Investigation Sampling Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Site	Matrix	Sampling Method	Field Parameters	Lab Parameters	USEPA Method	Primary Samples	QA/QC Samples					Matrix Total*
							Trip Blank	Rinsate Blank	Field Blank	Field Duplicate	MS/MSD	
IRP Site No. 1 (cont.)	Surface Soil 10 Locations	Surface Sampling	Soil headspace screening using PID/field TPH	TPH	WTPH-HCID (1) WTPH - G/D/HO (2)	10			1	1	1	12
			Soil Classification	Radionuclides	SM-7110A/B, 903.1, 904.0	10			1	1	1	12
	Groundwater	Geoprobe (field lab)	Temperature pH	Selected VOCs	8010/8020	22				2	1	25
			Specific conductance	TPH	WTPH-HCID (1)	22				2	1	25
		Monitoring Wells (per round)	Temperature	PP Metals	6010/6020/7470	6		1	1	1	1	8
	4 RI MWs 2 PA/SI MWs		pH	VOCs	5030/8260	6	1	1	1	1	1	8
			Specific conductance	SVOCs	3550/8270	6		1	1	1	1	8
				TPH	WTPH-HCID (1)	6		1	1	1	1	8
			Turbidity	Radionuclides	SM-7110A/B, 903.1, 904.0	6		1	1	1	1	8

Notes:

VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
PP Metals = Priority Pollutant metals
TPH = Total petroleum hydrocarbons
QA/QC = Quality assurance/quality control
MS/MSD = Matrix spike/matrix spike duplicate
USEPA = United States Environmental Protection Agency
PID = Photoionization detector
RI = Remedial Investigation
PA/SI = Preliminary Assessment/Site Inspection
MW = Monitoring Well
* = Blank samples not included in matrix total
(1) = State of Washington TPH analysis - hydrocarbon screening/identification method
(2) = State of Washington TPH analysis - gasoline/diesel/heavy oil quantification method

KCSlip4 41526
SEA408056

FINAL

TABLE 3-2
Phase II Remedial Investigation Sampling Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Matrix	Sampling Method	Field Parameters	Laboratory Parameters	Analytical Method	Primary Sample Analyses	QA/QC Samples					Total Laboratory Analyses
						Trip Blank	Rinsate Blank	Field Blank	Field DUP	MS/MSD	
Soil Vapor	StrataProbe - 40 locations	None	VOCs	USEPA 8021B	40	2	4	2	4	--	52
Soil	StrataProbe - 20 locations	Organic vapors	VOCs	USEPA 8260	20	1	2	1	2	1	27
			TPH	WTPH-HCID	3	--	1	1	1	--	6
	MW borings - 5 locations	Organic vapors	VOCs	USEPA 8260	5	1	1	—	--	--	7
Groundwater	StrataProbe - 20 locations	None	VOCs	USEPA 8021B	20	1	1	1	2	1	26
	8 existing MWs, 5 new MWs, quarterly for 1 year	S.C., Turbidity, pH, Temperature, D.O., Redox potential	VOCs	USEPA 8260	52	8	5	8	5	3	81

Notes:
VOCs = Volatile organic compounds
TPH = Total petroleum hydrocarbons
WTPH-HCID = Washington TPH - hydrocarbon identification method
QA/QC = Quality assurance/quality control
DUP = Duplicate sample
S.C. = Specific conductance
D.O. = Dissolved oxygen content
USEPA = United States Environmental Protection Agency
MS/MSD = Matrix spike/matrix spike duplicate
MW = Monitoring well

KCSlip4 41527
SEA408057

concentrations above PSGs. PCE has been detected in select samples collected from two background (upgradient) monitoring wells; the majority of the detections have been only slightly above PSGs. Dissolved TCE in groundwater is the only consistently detected COC considered to pose a potential threat to human health or the environment. A summary of organic compounds detected in groundwater monitoring wells is provided on Table 3-3; the locations of the monitoring wells are shown on Figure 3-7. Table 3-4 provides a summary of monitoring well construction details.

TCE has been detected in groundwater samples collected in the southern portion of the Station. The samples were collected from both direct-push (ie. Geoprobe/Strataprobe) borings and groundwater monitoring wells installed during the RI. The RI results for TCE in groundwater are depicted on Figure 3-8. TCE was detected in direct-push samples GP-2, GP-4, GP-5, GP-36, GP-37, and GP-38, at concentrations ranging from 1.0 to 25 micrograms per liter (μg/l). TCE also has been detected in groundwater samples collected from monitoring wells MW-4, MW-5, MW-6, MW-7, and MW-8, at concentrations ranging from 2.0 to 83 μg/l.

The direct-push groundwater sample results are considered screening-level data. The groundwater samples collected from monitoring wells, on the other hand, provide definitive data for groundwater characterization. Only three groundwater samples collected from monitoring wells MW-6 and MW-8 in February and May 1999 had TCE concentrations exceeding the Model Toxics Control Act (MTCA) Method A Cleanup Level of 5.0 μg/l.

An on-site source area for the TCE detected in groundwater has not been identified at the Station. Out of 27 soil samples analyzed for VOCs during the RI, only one was found to contain TCE. The TCE concentration reported in this sample (0.17 milligrams per kilogram) was below the MTCA Method A Cleanup Level of 0.5 milligrams per kilogram. Furthermore, this soil sample was collected at the depth of the water table in the boring for monitoring well MW-3, and thus may have contained TCE-impacted groundwater that biased the analytical results. Chlorinated VOCs were not detected in any of the other RI soil samples. As discussed in the Phase II RI Report (ERM 1999a), it appears that the TCE detected in groundwater at the Seattle ANGS may be related to the groundwater contamination at the Boeing facility immediately south of the Station.

KCSlip4 41528

SEA408058

TABLE 3-3

Organic Compounds Detected in Groundwater Monitoring Wells
143rd CCSQ, Seattle ANGS, Seattle, Washington

Location	Date	Acetone	Toluene	1,1-Dichloroethane	1,1,1-Trichloroethane	Cis-1,2-Dichloroethene	1,3,5-Trimethylbenzene	Trichloroethene	Tetrachloroethene
BS-004PZ (Background Well)	9/17/96	ND	(ND)	0.3	3.7	ND	ND	ND	3.8
	9/17/96 (dup)	ND	(ND)	0.3	3.8	ND	ND	ND	3.8
	1/14/97	ND	ND	ND	2.4	ND	ND	ND	**5.1**
	4/11/97	ND	ND	ND	3.3	ND	ND	ND	**17**
	7/10/97	ND	ND	ND	1.8	ND	ND	ND	(ND)
	9/2/98	ND	ND	ND	ND	ND	ND	ND	2.0
	11/25/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/19/99	ND	ND	ND	ND	ND	ND	ND	**6.8**
BS-005PZ	9/17/96	ND	ND	ND	ND	ND	0.2	ND	ND
	1/15/97	ND	ND	ND	ND	ND	ND	ND	ND
	4/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	7/11/97	ND	ND	ND	ND	ND	ND	ND	4.7
	9/1/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/25/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	ND	ND	ND	ND	ND
BS-006PZ	9/17/96	ND	ND	ND	ND	ND	0.2	ND	ND
	1/14/97	ND	ND	ND	ND	ND	ND	ND	ND
	4/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	7/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	9/2/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/24/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	ND	ND	ND	ND	ND
MW-1 (Background Well)	10/18/96	ND	ND	ND	ND	ND	ND	ND	ND
	12/17/96	ND	ND	ND	ND	ND	ND	ND	ND
	1/14/97	ND	1.1	ND	ND	ND	ND	ND	ND
	4/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	7/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	9/1/98	ND	6.0	ND	ND	ND	ND	ND	ND
	11/25/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	**5.2**
	5/19/99	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	10/18/96	ND	ND	ND	ND	ND	ND	ND	ND
	12/17/96	ND	ND	ND	ND	ND	ND	ND	ND
	1/15/97	ND	ND	ND	ND	ND	ND	ND	ND
	1/15/97 (dup)	ND	ND	ND	ND	ND	ND	ND	ND
	4/10/97	ND	ND	ND	ND	ND	ND	ND	ND
	7/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	9/2/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/25/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	ND	ND	ND	ND	ND
MW-3	10/18/96	18	ND	ND	ND	ND	ND	ND	ND
	10/18/96 (dup)	20	ND	ND	ND	ND	ND	ND	ND
	12/17/96	ND	ND	ND	ND	ND	ND	ND	ND
	12/17/96 (dup)	ND	ND	ND	ND	ND	ND	ND	ND
	1/15/97	ND	ND	ND	ND	ND	ND	ND	ND
	4/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	7/11/97	ND	ND	ND	ND	ND	ND	ND	ND
	9/2/98	ND	ND	ND	ND	ND	ND	ND	ND
	9/2/98 (dup)	ND	ND	ND	ND	ND	ND	ND	ND
	11/24/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/24/98 (dup)	ND	ND	ND	ND	ND	ND	ND	ND
	2/25/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	ND	ND	ND	ND	ND

KCSlip4 41529

SEA408059

TABLE 3-3

Organic Compounds Detected in Groundwater Monitoring Wells
143rd CCSQ, Seattle ANGS, Seattle, Washington

Location	Date	Acetone	Toluene	1,1-Dichloroethane	1,1,1-Trichloroethane	Cis-1,2-Dichloroethene	1,3,5-Trimethylbenzene	Trichloroethene	Tetrachloroethene
MW-4	10/18/96	11	ND	ND	ND	ND	ND	3.9	ND
	12/17/96	ND	ND	ND	ND	ND	ND	2.7	ND
	1/14/97	ND	ND	ND	ND	ND	ND	3.4	ND
	4/11/97	ND	ND	ND	ND	ND	ND	3.2	ND
	7/11/97	ND	ND	ND	ND	ND	ND	2.8	ND
	9/2/98	ND	ND	ND	ND	ND	ND	2.0	ND
	11/24/98	ND	ND	ND	ND	ND	ND	3.4	ND
	2/24/99	ND	ND	ND	ND	ND	ND	2.6	ND
	2/24/99 (dup)	ND	ND	ND	ND	ND	ND	2.6	ND
	5/18/99	ND	ND	ND	ND	ND	ND	2.9	ND
MW-5	10/18/96	ND	ND	ND	ND	5.6	ND	ND	ND
	12/17/96	ND	ND	ND	ND	4.9	ND	ND	ND
	1/14/97	ND	ND	ND	ND	2.7	ND	ND	ND
	4/11/97	ND	ND	ND	ND	1.4	ND	ND	ND
	4/11/97 (dup)	ND	ND	ND	ND	1.6	ND	ND	ND
	7/10/97	ND	ND	ND	ND	3.5	ND	2.1	(ND)
	7/10/97 (dup)	ND	ND	ND	ND	2.8	ND	ND	ND
	9/2/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/24/98	ND	ND	ND	ND	3.2	ND	ND	ND
	2/25/99	ND	ND	ND	ND	1.7	ND	ND	ND
	5/18/99	ND	ND	ND	ND	ND	ND	ND	ND
MW-6	9/2/98	ND	ND	ND	ND	ND	ND	3.0	ND
	11/24/98	ND	ND	ND	ND	ND	ND	3.0	ND
	2/25/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	ND	1.0	ND	**5.7**	ND
MW-7	9/2/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/24/98	ND	ND	ND	ND	ND	ND	3.8	ND
	2/25/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	ND	ND	ND	ND	ND
MW-8	9/2/98	ND	ND	ND	ND	ND	ND	3.0	ND
	11/24/98	ND	ND	ND	ND	ND	ND	3.3	ND
	2/24/99	ND	ND	ND	ND	39	ND	**83**	ND
	2/24/99 (dup)	ND	ND	ND	ND	42	ND	**87**	ND
	5/18/99	ND	ND	ND	ND	4.5	ND	**19**	ND
	5/18/99 (dup)	ND	ND	ND	ND	4.7	ND	**21**	ND
MW-9	9/1/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/24/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/18/99	ND	ND	ND	1.4	ND	ND	ND	1.8
MW-10	9/1/98	ND	ND	ND	ND	ND	ND	ND	ND
	11/25/98	ND	ND	ND	ND	ND	ND	ND	ND
	2/24/99	ND	ND	ND	ND	ND	ND	ND	ND
	5/19/99	ND	ND	ND	ND	ND	ND	ND	ND
RI Project Screening Goal		800	40	800	200	70	0.507	5.0	5.0

Notes:

All concentrations in micrograms per liter (µg/l)
ND = Not detected above laboratory method reporting limit
(ND) = A positive detection was reported by the laboratory for this constituent in the sample indicated. The sample result was qualified as not detected based on a detection of the constituent in an associated quality control blank (United States Environmental Protection Agency Contract Laboratory Program "10x" and "5x" rules).
dup = Duplicate sample
RI = Remedial Investigation
Shaded cell/bold typeface indicates a value exceeding the associated RI project screening goal.

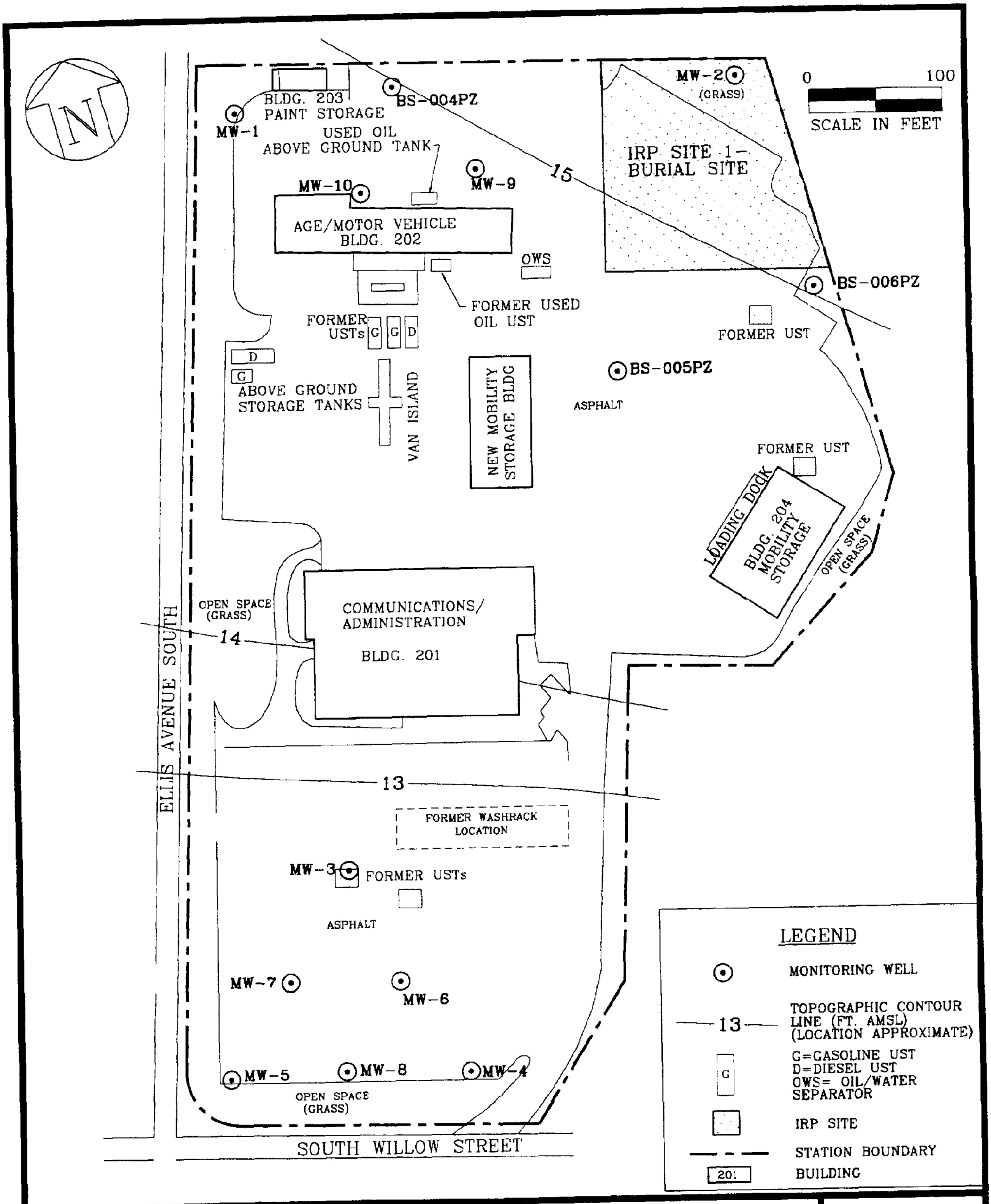


FIGURE 3-7

GROUNDWATER MONITORING WELL LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

S:\cad\dwgs\6051\41\60514129

KCSlip4 41531

SEA408061

TABLE 3-4

Summary of Monitoring Well Construction Details
143rd CCSQ, Seattle ANGS, Seattle, Washington

Location	IRP Investigation	Date Completed	Measuring Point Elevation (ft-amsl)	Total Depth (ft-bgs)	Casing Diameter/ Material	Wellhead Completion	Screen Slot Size (inches)	Annular Seal	Screened Interval (ft-bgs)	Top of Sand Filter Pack (ft-bgs)
BS-004PZ (Background Well)	PA/SI	7/14/94	14.66	20.5	2-inch PVC	Flush	0.010	5-feet BC	9.0 - 19.0	7.0
MW-1 (Background Well)	Phase I RI	10/16/96	14.92	205	2-inch PVC	Flush	0.010	2-feet BC	10.0 - 20.0	7.5
BS-005PZ	PA/SI	7/14/94	14.39	20.5	2-inch PVC	Flush	0.010	5-feet BC	9.0 - 19.0	7.0
BS-006PZ	PA/SI	7/14/94	14.59	20.5	2-inch PVC	Flush	0.010	5-feet BC	9.0 - 19.0	7.0
MW-2	Phase I RI	10/16/96	14.60	20.5	2-inch PVC	Flush	0.010	2-feet BC	10.0 - 20.0	7.5
MW-3	Phase I RI	10/17/96	11.88	20.5	2-inch PVC	Flush	0.010	2-feet BC	10.0 - 20.0	7.5
MW-4	Phase I RI	10/17/96	12.05	20.5	2-inch PVC	Flush	0.010	2-feet BC	10.0 - 20.0	7.5
MW-5	Phase I RI	10/17/96	13.94	20.5	2-inch PVC	Flush	0.010	2-feet BC	10.0 - 20.0	7.5
MW-6	Phase II RI	8/27/98	11.62	20.5	2-inch PVC	Flush	0.010	2-feet BC	5.0 - 20.0	4.0
MW-7	Phase II RI	8/27/98	12.17	20.5	2-inch PVC	Flush	0.010	2-feet BC	5.0 - 20.0	4.0
MW-8	Phase II RI	8/27/98	11.90	20.5	2-inch PVC	Flush	0.010	2-feet BC	5.0 - 20.0	4.0
MW-9	Phase II RI	8/27/98	14.30	20.5	2-inch PVC	Flush	0.010	2-feet BC	5.0 - 20.0	4.0
MW-10	Phase II RI	8/27/98	14.97	20.5	2-inch PVC	Flush	0.010	2-feet BC	5.0 - 20.0	4.0

Notes:

(ft-amsl) = Feet above mean sea level
(ft-bgs) = Feet below ground surface
RI = Remedial Investigation
PA/SI = Preliminary Assessment/Site Inspection
PVC = Polyvinyl chloride
BC = Bentonite chips

KCSlip4 41532
SEA408062

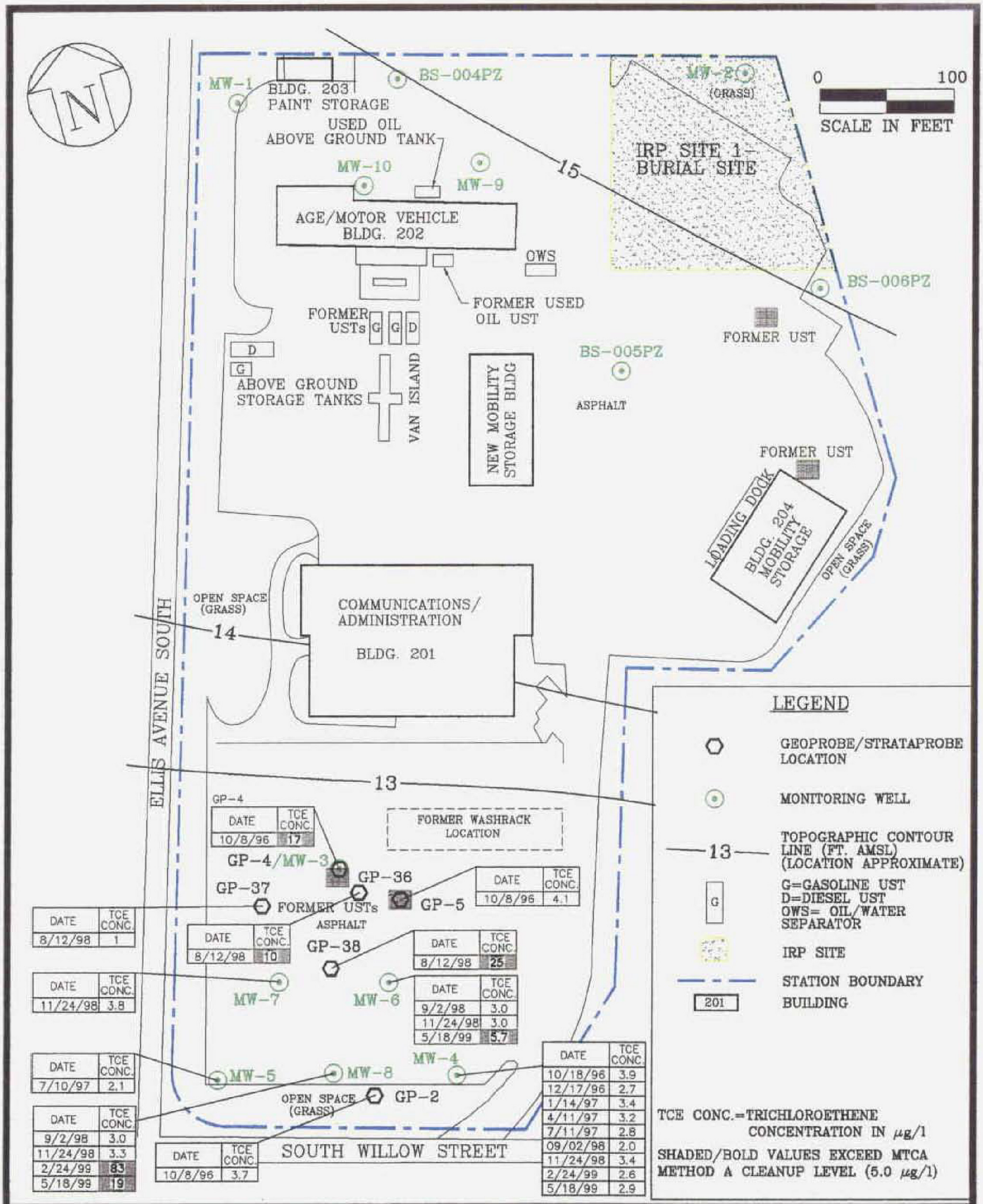


FIGURE 3-8

TRICHLOROETHENE
IN GROUNDWATER

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

G:\\6067\21\60672107.DWG

KCSlip441533

SEA408063

TCE has been detected in a number of shallow monitoring wells at the Boeing site, at concentrations of the order of 10 to 1,000 μg/l (Boeing 1998).

KCSlip4 41534

SEA408064

SECTION 4.0

ENVIRONMENTAL SETTING

This section describes the environmental setting at the Seattle ANGS to establish a reference for the work conducted under the IRP.

4.1 Climate

The climate in the Seattle area is characterized by mild summers and cool winters, with long spring and fall seasons. In winter, the average daily temperature ranges from 37 to 47 degrees Fahrenheit (°F), while in summer the average daily temperature ranges from 55 to 72 °F. The average annual precipitation is 38.84 inches, including 7.4 inches of snow. The greatest percentage of rainfall occurs in the winter months from November to January. The average monthly precipitation ranges from 0.89 inches in July to 6.29 inches in December. The heaviest 24-hour rainfall of 3.74 inches was recorded on 5-6 October 1981. Rainfall intensity, based on a 2-year, 24-hour duration, is 2.0 inches. Free-water surface evaporation in the Seattle area is approximately 25 inches per year, resulting in a net precipitation of 13.84 inches per year. The prevailing wind is from the southwest, and the highest average wind speed of 9.8 miles per hour occurs during March (OpTech 1995).

4.2 Topography

The Seattle ANGS is in King County in the Puget Sound Lowlands physiographic province. The Puget Sound Lowlands is a north-south trending structural and topographic depression bordered on the west by the Olympic Mountains and on the east by the Cascade Range. The Lowlands extend north from the Oregon-Washington state line to the Canadian border.

The terrain at the Station is flat and level, with a surface elevation of approximately 14 feet above sea level.

4.3 Geology

A geologic map of the Seattle, Washington area and a generalized stratigraphic column for the Puget Sound area are presented on Figures 4-1 and 4-2, respectively.

The Seattle ANGS is situated in the central portion of the Puget Sound Lowlands, a broad glacial drift plain that is dissected by a network of deep marine embayments. The site is located within the north-south trending Duwamish Valley on the Duwamish Waterway floodplain, a former marine embayment that has been filled with sediment since the end of the last glaciation, referred to locally as the Vashon glaciation. The Duwamish Valley is bounded on the east and west by uplands of glacial drift and bedrock.

Glacial sediment deposits known collectively as the Vashon Drift represent the last major advance and retreat of glacial ice in the Puget Sound area. These deposits commonly overlie a sequence of older glacial and nonglacial sediments throughout the site vicinity. Near the site, at least 75 feet of recent alluvium deposited by the Duwamish River overlies the Vashon Drift deposits.

Alluvial deposits in the Duwamish Valley primarily range from silt through silty sand to fine to medium sand. The alluvial deposits exhibit gradation common to meandering rivers, which typically produce intermittent layering of silts and sands with occasional layers of peat and other organic material deposited in marsh areas.

In the 1910s, much of the Duwamish Valley was raised with fill to accommodate development. The meandering Duwamish River was channelized to its present position during this time. Prior to extensive filling and regrading in the vicinity of the Seattle ANGS between 1917 and 1919, a meander of the Duwamish River existed near the eastern site boundary. Fill materials in the former channel bed consist of up to 6 feet of silty sand to fine sand and up to 10 feet of coal ash, clinkers, and brick fragments. Soils below the coal combustion residue consist of fine sand with trace gravel to a depth of at least 35 feet bgs (OpTech 1995).

The subsurface data collected during the PA/SI and RI drilling activities indicate that the near-surface geology at the Seattle ANGS is predominantly composed of two units. The first unit is a silty sand fill

KCSlip4 41536

SEA408066

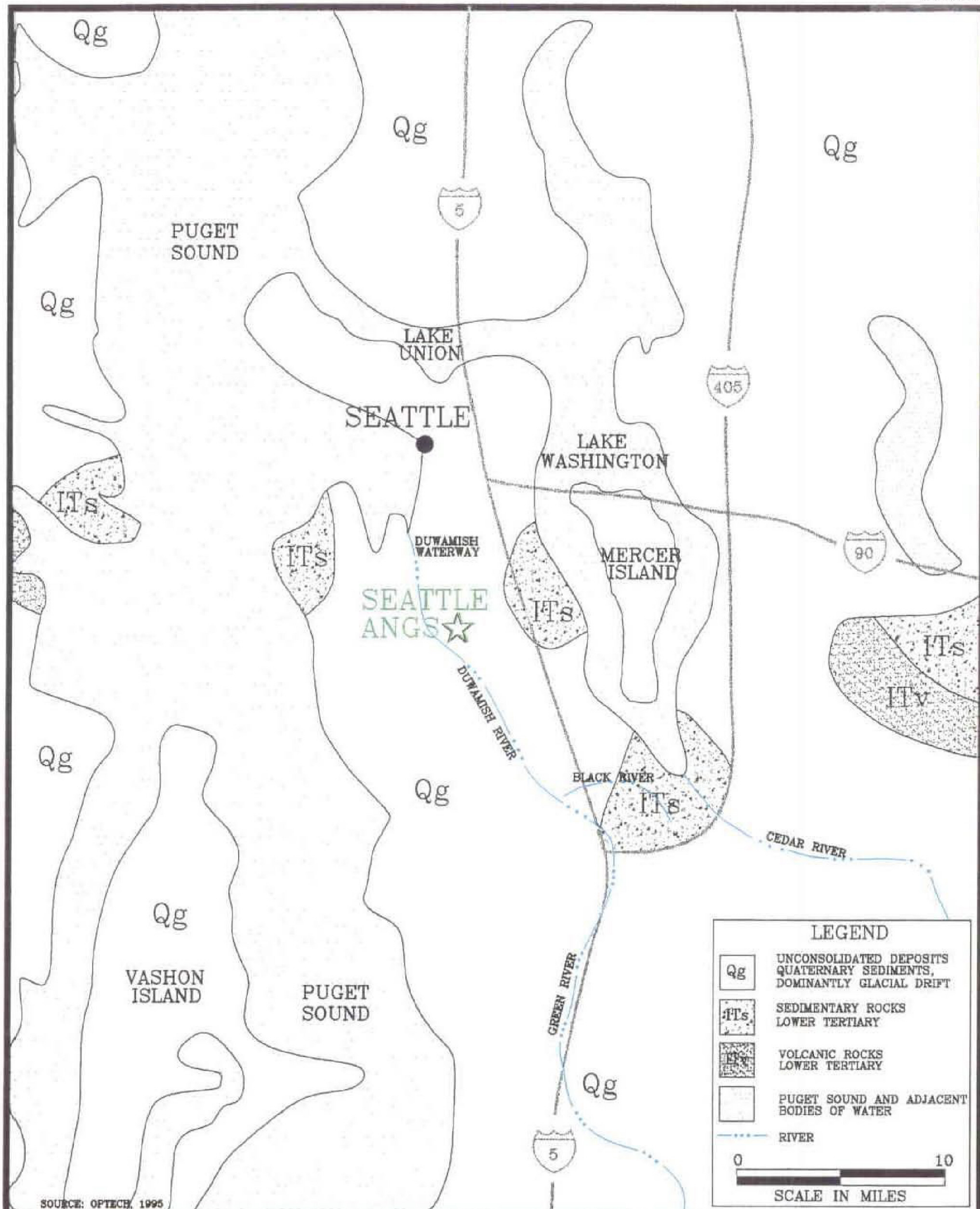


FIGURE 4-1

GEOLOGIC MAP OF THE SEATTLE, WASHINGTON AREA
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

S:\cad\dwgs\6051\41\60514112

KCSlip441537

SEA408067

PUGET LOWLAND

EPOCH		SOUTHERN		APPROXIMATE THICKNESS OF SOUTHERN UNITS (FEET)
HOLOCENE		RECENT ALLUVIUM		75
PLEISTOCENE	LATE	FRASER DRIFT	VASHON DRIFT	NA
PLEISTOCENE	LATE	SEDIMENTS OF THE NONGLACIAL OLYMPIA INTERVAL		NA
PLEISTOCENE		SALMON SPRINGS DRIFT	UPPER SALMON SPRINGS GRAVEL AND TILL	NA
PLEISTOCENE		SALMON SPRINGS DRIFT	SILT, PEAT AND ASH	NA
PLEISTOCENE		SALMON SPRINGS DRIFT	LOWER SALMON SPRINGS GRAVEL AND TILL	NA
PLEISTOCENE	EARLY	PUYALLUP FORMATION (INTERGLACIAL)		130
PLEISTOCENE	EARLY	STUCK DRIFT		NA
PLEISTOCENE	EARLY	ALDERTON FORMATION (INTERGLACIAL)		25
PLEISTOCENE	EARLY	ORTING DRIFT		200

NORTHERN			AGE (YEARS)
			10,000
FRASER DRIFT	SUMAS DRIFT		11,000
FRASER DRIFT	EVERSON GLACIOMARINE DRIFT		13,000
FRASER DRIFT	VASHON DRIFT	VASHON TILL	
FRASER DRIFT	VASHON DRIFT	ESPERANCE SAND	
FRASER DRIFT	VASHON DRIFT	LAWTON CLAY	20,000
SEDIMENTS OF THE NONGLACIAL OLYMPIA INTERVAL			28,000
POSSESSION DRIFT			42,000
			90,000
WHIDBEY FORMATION (INTERGLACIAL)			100,000
DOUBLE BLUFF DRIFT			250,000
			1,000,000
			2,000,000(?)

SOURCE: OPTECH, 1995

NA – NOT AVAILABLE

FIGURE 4-2

GENERALIZED STRATIGRAPHIC COLUMN FOR THE PUGET SOUND LOWLANDS
143rd CCSQ, Seattle ANGS
Seattle, Washington

S:\cad\dwgs\8051\41\80514113

ERM

KCSlip4 41538

SEA408068

material present to a depth of approximately 8 feet bgs. The fill material is consistent with the descriptions of the material used to raise the Duwamish Valley for development in the 1910s. The second unit consists primarily of well-sorted, fine-grained sand present from approximately 8 feet bgs to the maximum depth explored at the Station during the PA/SI and RI (21.5 feet bgs). Figure 4-3 shows the locations of two geologic cross-sections through the Station generated from PA/SI and Phase I RI data; the cross sections referenced on Figure 4-3 are shown on Figures 4-4 and 4-5.

4.4 Soils

The United States Department of Agriculture classified the soil underlying the Seattle ANGS as unclassified urban land. Urban land is soil that has been modified by the disturbance of the natural layers with additions of fill material several feet thick to accommodate large industrial and housing installations. In the Duwamish Valley, the fill ranges from about 3 feet to more than 12 feet thick, and from gravelly sandy loam to gravelly loam in texture. The erosion hazard is slight to moderate (OpTech 1995).

Two soil borings were drilled at the Seattle ANGS and five Dutch cone penetrometer samples were analyzed by Hart Crowser and Associates, Inc., during soil studies conducted at the Station in 1974 and 1982. Sandy silt to silty sand was the most common sediment within the uppermost 10 feet of unconsolidated sediments. Sand, with occasional thin silty layers, was the predominant lithology encountered from a depth of 10 to 50 feet bgs (OpTech 1995).

4.5 Surface Water Hydrology

The Seattle ANGS is located approximately 1/2 mile from the main channel of the Duwamish Waterway, a major surface water drainage for western Washington. Between 1917 and 1919, the meanders of the Duwamish River within Seattle City limits were filled in and the Duwamish Waterway was formed. A portion of a meander near North Boeing Field was not filled in, and this became the present-day Slip No. 4 (see Figure 1-1).

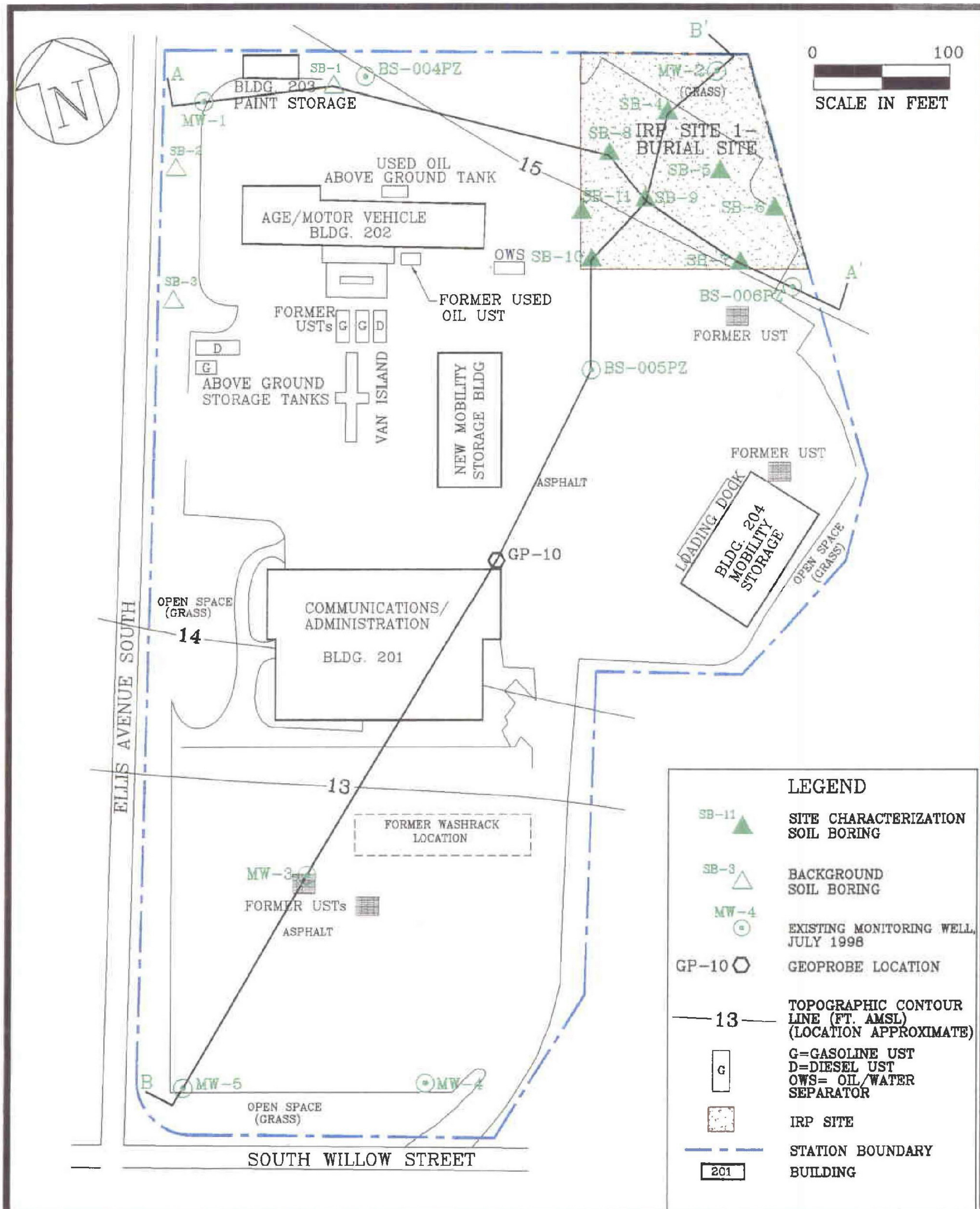


FIGURE 4-3

GEOLOGIC CROSS-SECTION
LOCATION MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

S:\cad\dwgs\6061\41\60614114

ERM

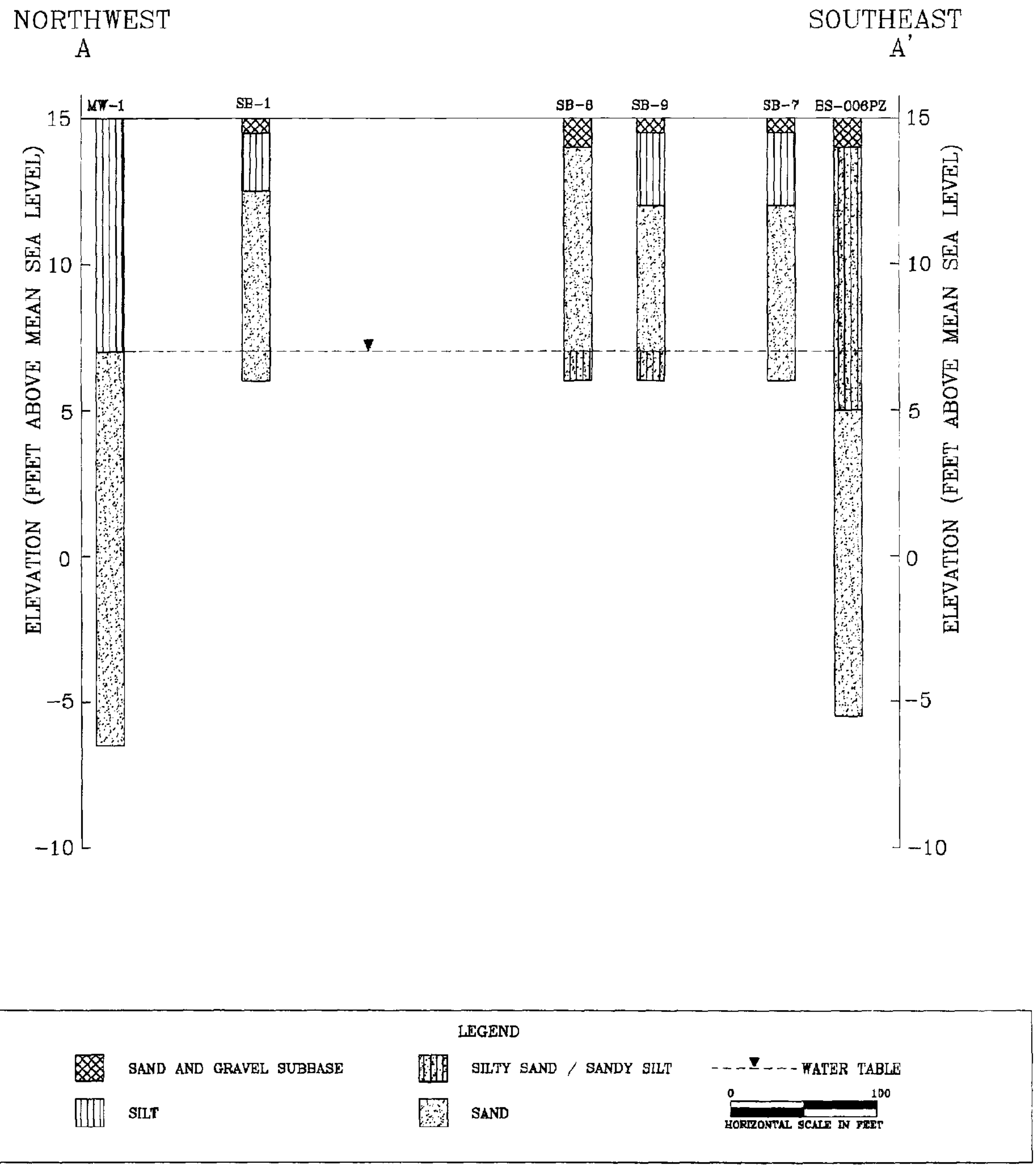


FIGURE 4-4

S:\cad\dwgs\6051\41\60514115

GEOLOGIC CROSS-SECTION A-A'

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

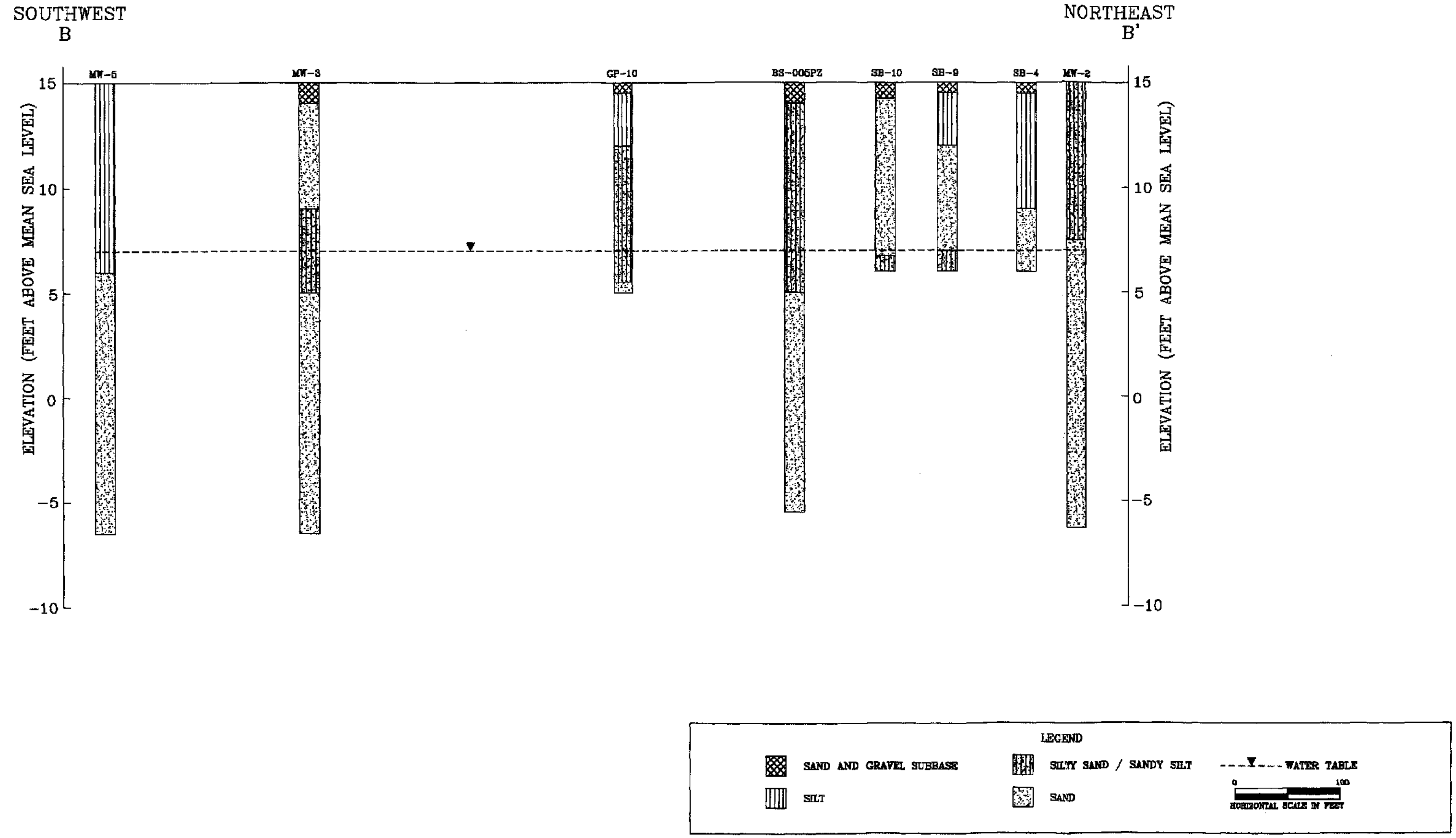


FIGURE 4-5

GEOLOGIC CROSS-SECTION B-B'

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

S:\cad\dwgs\0051\41\00514116

KCSlip4 41542

SEA408072

The Federal Emergency Management Agency reported that the Duwamish drainage basin comprises 450 square miles. The drainage basin includes the Duwamish and Green Rivers. Approximately 3.5 miles northwest of the Station, the Duwamish Waterway discharges into Elliot Bay on the Puget Sound.

The Duwamish Waterway is the only fresh water body downgradient of the Station. According to the Seattle Water Department, the Duwamish Waterway is not used for drinking water (OpTech 1995). Surface water runoff at the Seattle ANGS flows into a series of catch basins that are tied into the municipal storm sewer. Figure 4-6 illustrates the storm drain system at the Station.

4.6 Hydrogeology

This section describes the regional and local hydrogeology in the vicinity of the Seattle ANGS and summarizes the hydrogeologic conditions encountered at the Station during the RI.

4.6.1 Regional Hydrogeology

Groundwater in the Duwamish Valley occurs in two lithostratigraphic units. Shallow groundwater is present within a river alluvium unit. This unit underlies the Seattle ANGS and is described in the following section. Deeper groundwater reportedly exists beneath the river alluvium unit in unconsolidated glacial deposits (Luzier 1969). Characteristics of this deeper aquifer are unknown; groundwater probably flows toward the Duwamish River and thus to Elliot Bay within the deeper aquifer (OpTech 1995).

The Seattle Water Department has no municipal wells within 4 miles of the Station, and records obtained from the WDOE indicate that there are no private drinking water wells within a 1-mile radius of the Station. The surrounding population obtains drinking water from a municipal water source (OpTech 1995).

The environmental database report prepared as part of the Phase I RI/FS Work Plan (ERM 1996) presents data regarding water supply wells in the United States Environmental Protection Agency (USEPA) database and

KCSlip4 41543

SEA408073

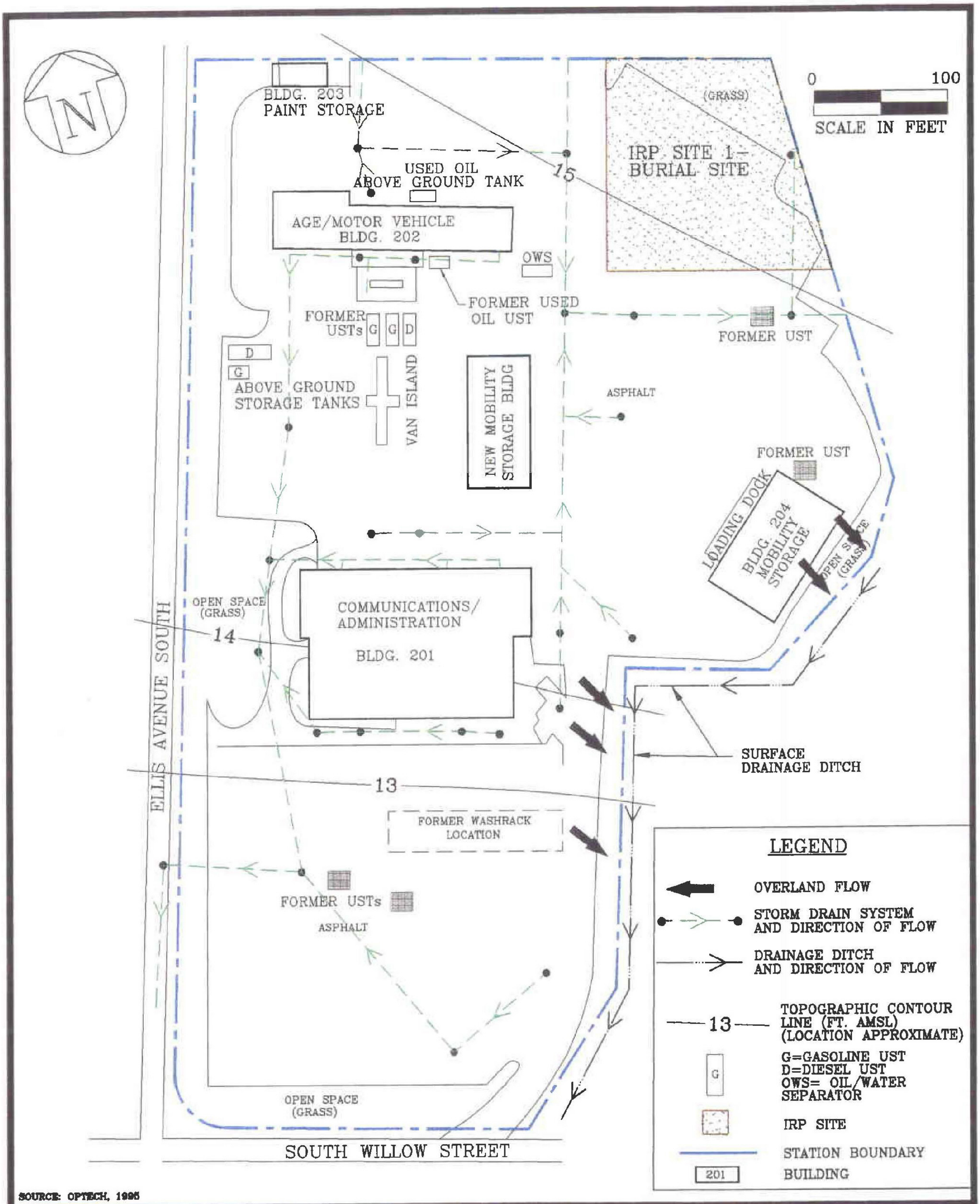


FIGURE 4-6

SURFACE WATER DRAINAGE MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

KCSlip441544

SEA408074

wells included in the United States Geological Survey database. The wells identified in the environmental database report are greater than 1 mile from the Seattle ANGS.

The PA/SI Report identified wells within a 4-mile radius of the Seattle ANGS. The wells were identified based on a review of State records. Construction details, use, and ownership information for the wells identified during the PA/SI are summarized in OpTech (1995).

4.6.2 Local Hydrogeology

Unconfined groundwater generally occurs within the upper part of the recent river alluvium at depths of 4 to 11 feet bgs in the vicinity of the Seattle ANGS. Previous investigations in the area have found that groundwater elevations are influenced by seasonal precipitation, and, if close enough to the Duwamish Waterway, by tidal fluctuations. Groundwater flow in the vicinity of the Station is generally toward the west, southwest, and south, toward the Duwamish Waterway, at a gradient of approximately 0.002 feet per foot (OpTech 1995).

Hydrogeologic data collected during the RI indicate that unconfined groundwater exists at depths of 6 to 10 feet bgs at the Seattle ANGS. Representative potentiometric surface maps are shown on Figures 4-7, 4-8, and 4-9. The groundwater flow direction across the Station, as inferred from the potentiometric surface maps, is toward the south. As shown on Figures 4-7 and 4-8, groundwater at the Station responds quickly to seasonal precipitation during the wet season; groundwater elevations increased approximately 2 feet between October 1996 and January 1997.

Slug tests were performed on monitoring well MW-3 during the Phase I RI. Hydraulic conductivity estimates ranging from 1.25×10^{-4} to 6.09×10^{-4} feet per second were calculated for monitoring well MW-3. These results are consistent with the predominant sand lithology at the site.

KCSlip4 41545

SEA408075

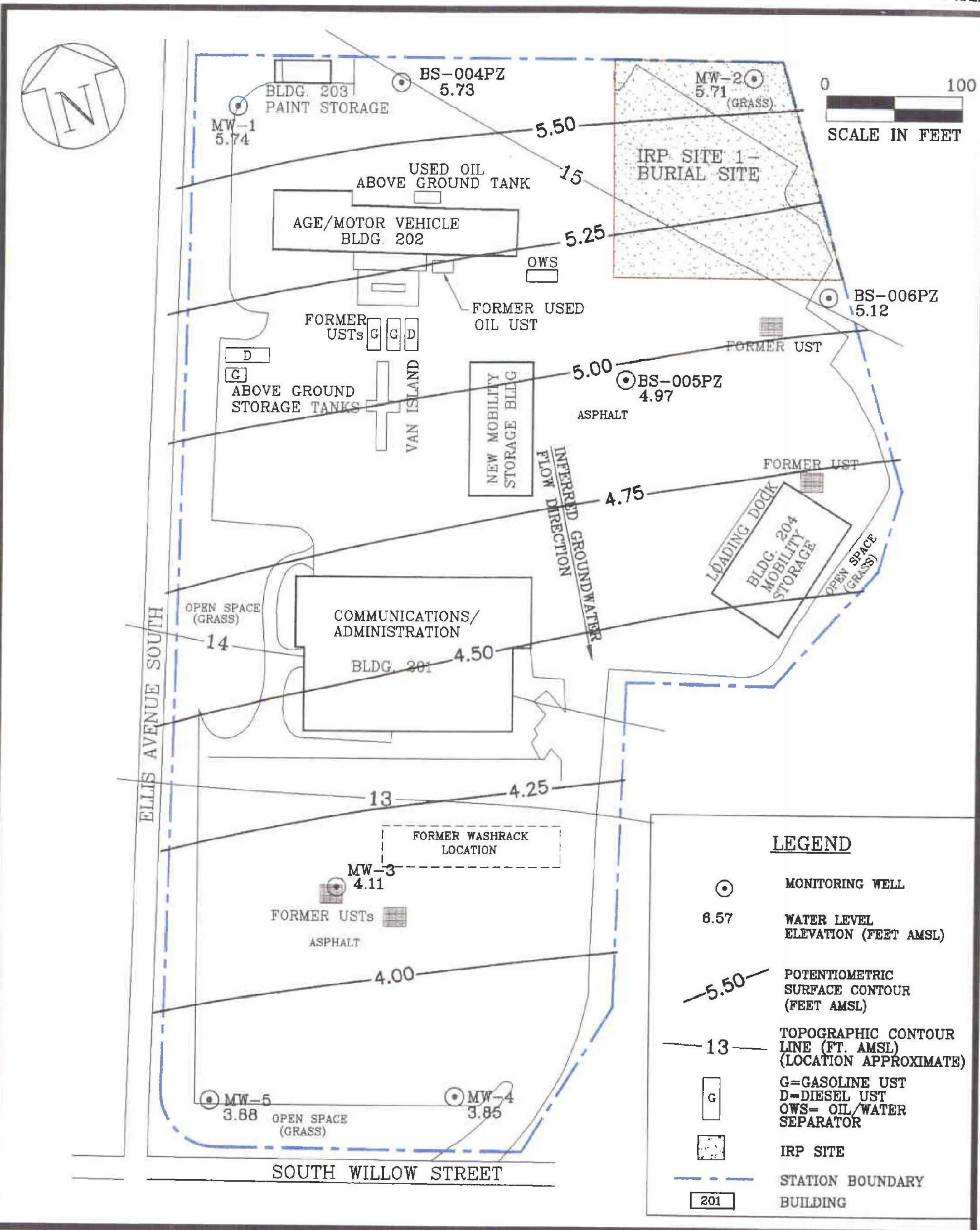


FIGURE 4-7

S:\cad\dwgs\6051\41\60514118

POTENTIOMETRIC SURFACE
22 OCTOBER 1996

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

KCSlip441546

SEA408076

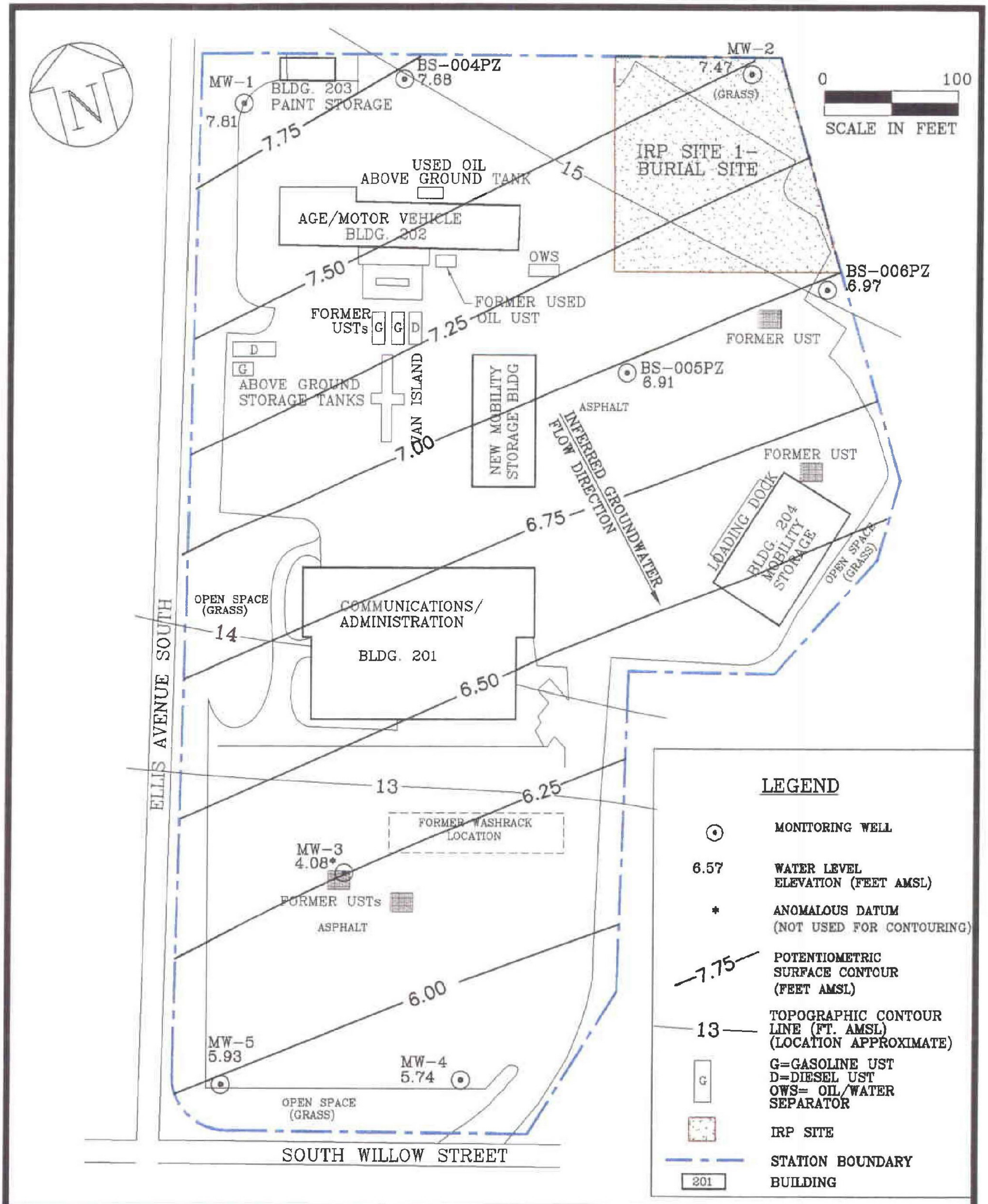


FIGURE 4-8

POTENTIOMETRIC SURFACE
14-15 JANUARY 1997

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

S:\cad\dwgs\6051\41\60514119

KCSlip441547

SEA408077

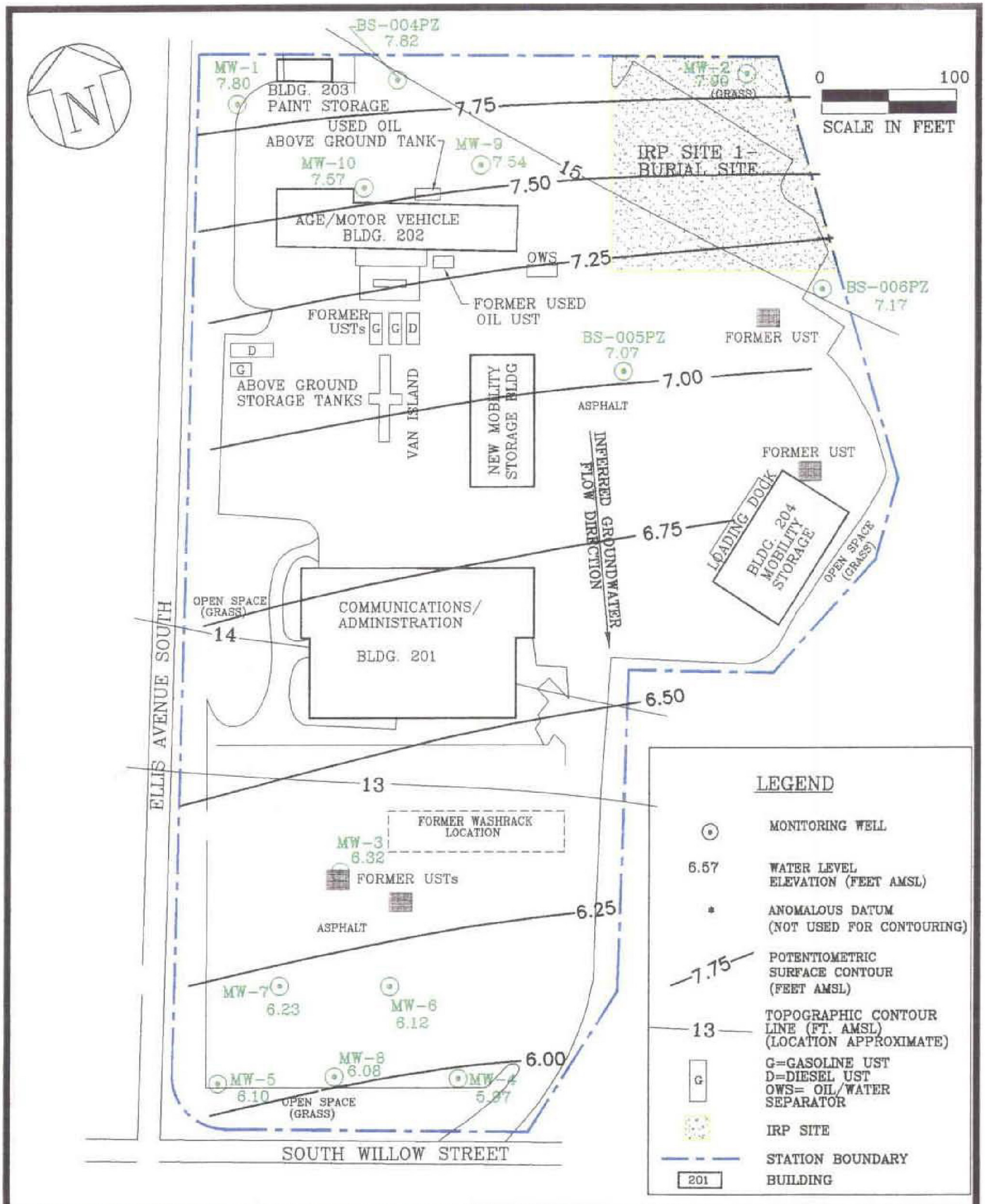


FIGURE 4-9

POTENTIOMETRIC SURFACE
24 FEBRUARY 1999

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

G:\\6067\21\60672106.DWG

KCSlip441548

SEA408078

SECTION 5.0

PERMITS

No Federal, State, or local permits or notices are required for the planned groundwater monitoring activities described in this Work Plan. Field work will be scheduled and coordinated with the ANG Project Manager, the local ANG Environmental Coordinator, and Seattle ANGS personnel.

KCSlip4 41549

SEA408079

SECTION 6.0

INVESTIGATIVE APPROACH

This section describes the investigative approach for the 1999-2000 groundwater monitoring program at the Seattle ANGS.

6.1 Groundwater Monitoring Program Objective

Groundwater monitoring will be conducted at the Seattle ANGS to supplement the results of the RI phases with additional data needed to evaluate remedial options for groundwater contamination.

6.2 General Approach

The 1999-2000 groundwater monitoring program will consist of quarterly groundwater monitoring for 1 year and analytical testing of groundwater samples. Groundwater samples will be collected from the 13 existing monitoring wells at the Seattle ANGS (Figure 3-7).

The groundwater samples will be analyzed for VOCs. The analytical results from the quarterly monitoring will be evaluated for compliance with ARARs in accordance with MTCA regulations (WDOE 1996) and related guidance.

6.3 Monitoring Program Activities

This section describes the specific activities to be performed during the 1999-2000 groundwater monitoring program.

6.3.1 Groundwater Sampling

Each of the 13 groundwater monitoring wells at the Seattle ANGS (MW-1 through MW-10, BS-004PZ, BS-005PZ, and BS-006PZ) will be

KCSlip4 41550

SEA408080

sampled during the quarterly sampling events. Prior to sample collection, depth to groundwater in the monitoring wells will be measured. The water level data will be used to prepare potentiometric surface maps and to estimate groundwater gradient and flow direction. After water levels are measured, the wells will be purged and groundwater samples collected using the low-flow methods discussed in Section 8.1.1.

6.3.2 Analytical Methods

The groundwater samples will be analyzed for VOCs by USEPA Method 8260. The 1999-2000 groundwater sampling program is summarized on Table 6-1. Details regarding quantitation limits and QA/QC for laboratory analyses are discussed in the QAPP (Appendix B). Analytical data generated during the project will be validated by a qualified chemist in accordance with USEPA Contract Laboratory Program guidelines.

6.4 Deviations from the Work Plan

Significant deviations from the activities, procedures, or analyses performed pursuant to this Work Plan will be discussed and approved in advance with the ANG Project Manager. Descriptions of such deviations will be included in the quarterly monitoring reports to be prepared following each sampling event (see Section 11.0).

KCSlip4 41551

SEA408081

FINAL

TABLE 6-1

1999-2000 Groundwater Sampling Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Matrix	Sampling Method	Field Parameters	Laboratory Parameters	Analytical Method	Total Primary Analyses	Estimated Total No. QA/QC Samples					Est. Total Laboratory Analyses
						Trip Blank	Rinsate Blank	Field Blank	Field DUP	MS/MSD	
Groundwater	13 existing MWs, quarterly for 1 year	S.C., Turbidity, pH, Temperature, D.O., Redox potential	VOCs	USEPA 8260	52	8	4	8	4	4	80

Notes:

VOCs = Volatile organic compounds
QA/QC = Quality assurance/quality control
DUP = Duplicate sample
S.C. = Specific conductance
D.O. = Dissolved oxygen content
USEPA = United States Environmental Protection Agency
MS/MSD = Matrix spike/matrix spike duplicate
MW = Monitoring well

KCSlip4 41552
SEA408082

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 7.0

FIELD INVESTIGATION PROCEDURES

This section summarizes field investigation procedures to be followed during the 1999-2000 groundwater monitoring program.

7.1 Water Level Data Collection

Prior to the start of sampling activities during each quarterly event, groundwater levels in the monitoring wells will be measured from a marked reference point at the top of each well casing using an electronic water level indicator. Water levels will be recorded to the nearest 0.01 foot. Groundwater elevations will be computed by subtracting the measured depth to water at each location from the elevation of the corresponding measuring point. Potentiometric surface maps for the Station will be prepared based on the computed groundwater elevations and will be included in the quarterly monitoring reports.

7.2 Groundwater Sampling

After water levels in the monitoring wells are measured as described in Section 7.1, the wells will be purged using a submersible pump and the low-flow purging method described in Section 8.1.1. Groundwater samples will be collected using the submersible pump. The samples will be submitted to a State-certified laboratory for analysis of VOCs by USEPA Method 8260.

KCSlip4 41554

SEA408084

SECTION 8.0

SAMPLE COLLECTION PROCEDURES

This section describes sample collection procedures. Groundwater sampling activities will conform to ANG site investigation protocols. Additional details regarding sample identification and control, data recording, and chain-of-custody documentation are provided in the site-specific QAPP (Appendix B).

8.1 Groundwater Sample Collection Procedures

Groundwater samples will be collected using low-flow purging and sampling methods. Reusable monitoring and sampling equipment will be decontaminated prior to use at each well using the procedures outlined in Section 9.0. Water levels in the wells will be measured before any samples are collected. A submersible pump will be used to purge the wells; groundwater samples will be collected directly from the pump discharge. Sample containers for VOC analyses will consist of 40-milliliter volatile organics analysis (VOA) vials with Teflon-lined septum lids, preserved with hydrochloric acid.

8.1.1 Low-Flow Well Purging

Low-flow purging and sampling methods will be used to obtain representative groundwater samples while minimizing the amount of purge water generated. The low-flow purging and sampling procedures outlined below supersede the procedures described in the QAPP. Low-flow well purging procedures to be used (as modified from Puls and Barcelona [1996] and applicable ANG protocols) are as follows:

1. A fresh piece of disposable polyethylene (or equivalent) tubing will be attached to the outlet of the decontaminated pump prior to well purging. The pump will be slowly lowered into the well to minimize the mixing of casing water and the suspension of any silt at the bottom of the well. The pump will be placed near the middle or slightly above the middle of the screened interval. The pumping rate will be adjusted

to approximately 100 to 500 milliliters per minute; the goal is to minimize drawdown in the well (ideally less than 10 centimeters drawdown).

To minimize delays in field parameter stabilization and potential bias in analytical testing results, vents or other potential sources of air bubbles in the pump discharge tubing or in-line flow cell will be identified and sealed off (or otherwise isolated) prior to purging or as soon as possible after purging begins.

2. Purge water temperature, pH, specific conductance, dissolved oxygen, oxidation-reduction (redox) potential, and turbidity will be monitored using an in-line flow cell. At a minimum, readings will be taken and recorded every 3 to 5 minutes.

3. Purging will be suspended when the following parameters have stabilized for three successive readings or when at least one well casing volume has been purged:

   - Temperature: ± 1 degree Celsius;
   - pH: ± 0.1 units;
   - Specific conductance: ± 10 percent; and
   - Dissolved oxygen or turbidity: ± 10 percent.

4. After well-purging criteria are satisfied, the in-line flow cell will be disconnected and groundwater samples will be collected in the 40-millimeter VOA vials.

5. The pump will be removed from the well, disposable tubing will be discarded, and the pump will be decontaminated as described in Section 9.0.

8.1.2 Sampling of Low-Yield Wells

When purging and sampling wells with relatively low yield rates, if continuous flow is not sustainable during well purging, the pump will be turned off and the well will be allowed to recover for a period not longer than 24 hours. After the water level in the well has recovered, the required samples will be collected with the pump placed near the middle of the screened interval.

8.2 Field Quality Assurance/Quality Control Samples

During each quarterly sampling event, approximately one field duplicate sample, one equipment rinsate blank, two field blanks, and two trip blanks will be submitted to the analytical laboratory to provide a means of assessing the data quality resulting from the field sampling program (Table 6-1). Field duplicate samples will be analyzed to assess the reproducibility of analytical results for individual samples. Rinsate, field, and trip blanks will be analyzed to check for potential contamination associated with sampling procedures, ambient conditions at the site, and/or sample packaging and transportation methods. Additional information regarding field QA/QC procedures is provided in the QAPP (Appendix B).

KCSlip4 41557

SEA408087

SECTION 9.0

EQUIPMENT DECONTAMINATION PROCEDURES

Reusable sampling equipment will be decontaminated prior to use at each monitoring well. The sampling equipment will be washed with an aqueous solution of laboratory-grade detergent (e.g., Alconox), followed by a rinse with American Society for Testing and Materials (ASTM) Type II reagent-grade water or deionozed water, a spray rinse with isopropanol, and a final rinse with ASTM Type II water or deionized water. Decontaminated equipment will be wrapped in aluminum foil (shiny side outward) or otherwise stored or positioned to preclude inadvertent contamination prior to reuse.

The submersible pump will be decontaminated by pumping the detergent solution through the pump for several minutes, followed by ASTM Type II water or deionized water. Equipment that does not come into direct contact with water samples (i.e., field parameter measurement probes) will be decontaminated by rinsing with ASTM Type II water or deionized water.

SECTION 10.0

INVESTIGATION-DERIVED WASTE MANAGEMENT

Purge water and decontamination water generated during sampling activities will be contained in 55-gallon drums. Each IDW drum will be marked with a description of the contents and the accumulation date. The purge water and decontamination water will be designated as dangerous waste or non-dangerous waste in accordance with Washington State Dangerous Waste Regulations (Washington Administrative Code [WAC] Chapter 173-303). The waste designation will be based on the analytical results for groundwater samples.

The Seattle ANGS is responsible for disposal of IDW. ERM will characterize and label wastes and recommend applicable and appropriate disposal or treatment methods. Where these wastes are determined to be dangerous wastes per WAC 173-303, ERM will prepare manifests as necessary. Purge water and decontamination water determined not to be a dangerous waste per WAC 173-303 will either be discharged to the sanitary sewer after obtaining approval from the local publicly owned treatment works (if necessary) or removed for off-site disposal by a licensed contractor.

KCSlip4 41559

SEA408089

SECTION 11.0

PROJECT SCHEDULE AND DELIVERABLES

The schedule for the Seattle ANGS 1999-2000 groundwater monitoring program is shown on Figure 11-1. Quarterly groundwater sampling events will be conducted in August and November 1999 and in February and May 2000. A draft quarterly monitoring report will be submitted following each sampling event (four reports total). The format of the quarterly monitoring reports will follow the ANG's suggested outline for groundwater monitoring technical memoranda, as presented below.

EXECUTIVE SUMMARY

1.0 INTRODUCTION/BACKGROUND

2.0 FIELD ACTIVITIES
- 2.1 Groundwater Sampling Procedures
- 2.2 Sample Collection Procedures
- 2.3 Groundwater Sample Analyses
- 2.4 Investigation-Derived Waste Management

3.0 RESULTS
- 3.1 Groundwater Level Data Results
- 3.2 Field Parameter Results
- 3.3 Analytical Results

4.0 CONCLUSIONS

5.0 REFERENCES

APPENDIX A	WATER LEVEL DATA
APPENDIX B	LABORATORY DATA SUMMARY SHEETS
APPENDIX C	QUALITY CONTROL/DATA VALIDATION REPORT
APPENDIX D	CHAIN-OF-CUSTODY FORMS

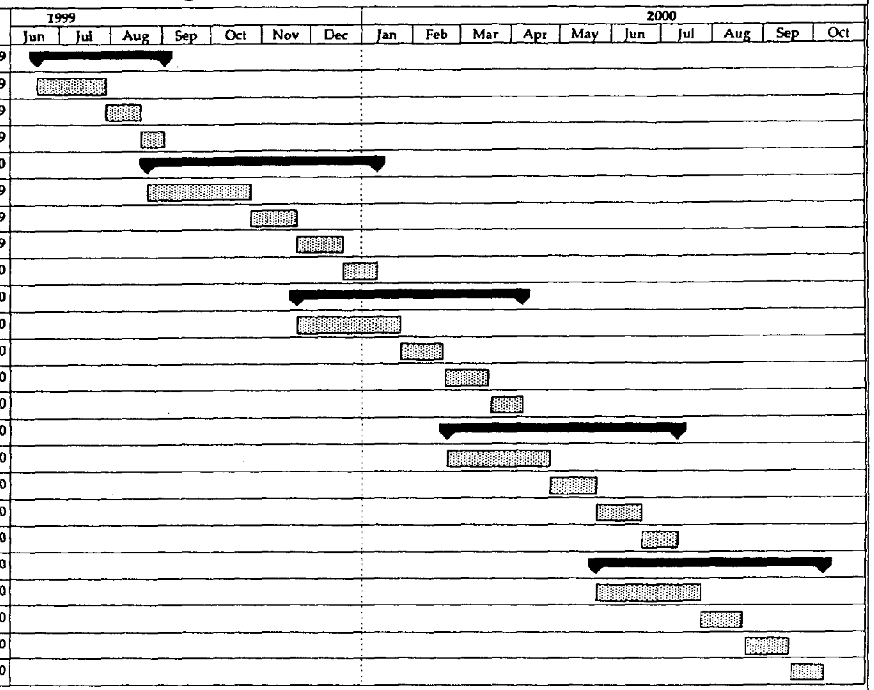
FIGURE 11-1

Seattle ANGS 1999-2000 Groundwater Monitoring Program Schedule

143rd CCSQ, Seattle ANGS, Seattle, Washington

Seattle ANGS Groundwater Monitoring, 1999-2000

ID	Task Name	Duration	Start	Finish
1	**Work Plan Preparation**	55d	Fri 6/18/99	Thu 9/2/99
2	Task 1A - Prepare Draft Groundwater Monitoring Work Plan	30d	Fri 6/18/99	Thu 7/29/99
3	ANG Review - Draft Groundwater Monitoring Work Plan	15d	Fri 7/30/99	Thu 8/19/99
4	Task 1B - Prepare Final Goundwater Monitoring Work Plan	10d	Fri 8/20/99	Thu 9/2/99
5	**1st Quarterly Sampling Event**	100d	Tue 8/24/99	Mon 1/10/00
6	Task 1C1 - 1st Qtr. GW Sampling, Analysis & Validation	45d	Tue 8/24/99	Mon 10/25/99
7	Task 1D1 - Prepare Draft 1st Qtr. GW Monitoring Report	20d	Tue 10/26/99	Mon 11/22/99
8	ANG Review - Draft 1st Qtr. GW Monitoring Report	20d	Tue 11/23/99	Mon 12/20/99
9	Task 1E1 - Prepare Final 1st Qtr. GW Monitoring Report	15d	Tue 12/21/99	Mon 1/10/00
10	**2nd Quarterly Sampling Event**	100d	Tue 11/23/99	Fri 4/7/00
11	Task 1C2 - 2nd Qtr. GW Sampling, Analysis & Validation	45d	Tue 11/23/99	Mon 1/24/00
12	Task 1D2 - Prepare Draft 2nd Qtr. GW Monitoring Report	20d	Tue 1/25/00	Fri 2/18/00
13	ANG Review - Draft 2nd Qtr. GW Monitoring Report	20d	Mon 2/21/00	Fri 3/17/00
14	Task 1E2 - Prepare Final 2nd Qtr. GW Monitoring Report	15d	Mon 3/20/00	Fri 4/7/00
15	**3rd Quarterly Sampling Event**	100d	Tue 2/22/00	Mon 7/10/00
16	Task 1C3 - 3rd Qtr. GW Sampling, Analysis & Validation	45d	Tue 2/22/00	Mon 4/24/00
17	Task 1D3 - Prepare Draft 3rd Qtr. GW Monitoring Report	20d	Tue 4/25/00	Mon 5/22/00
18	ANG Review - Draft 3rd Qtr. GW Monitoring Report	20d	Tue 5/23/00	Mon 6/19/00
19	Task 1E3 - Prepare Final 3rd Qtr. GW Monitoring Report	15d	Tue 6/20/00	Mon 7/10/00
20	**4th Quarterly Sampling Event**	100d	Tue 5/23/00	Fri 10/6/00
21	Task 1C4 - 4th Qtr. GW Sampling, Analysis & Validation	45d	Tue 5/23/00	Mon 7/24/00
22	Task 1D4 - Prepare Draft 4th Qtr. GW Monitoring Report	20d	Tue 7/25/00	Fri 8/18/00
23	ANG Review - Draft 4th Qtr. GW Monitoring Report	20d	Mon 8/21/00	Fri 9/15/00
24	Task 1E4 - Prepare Final 4th Qtr. GW Monitoring Report	15d	Mon 9/18/00	Fri 10/6/00



Project: Seattle ANGS 1999-2000 Groundwater Monitoring
Date: Mon 7/26/99

Subtask | Summary Task

Figure 11-1.MPP

KCSlip4 41561
SEA408091

SECTION 12.0

REFERENCES

The Boeing Company (Boeing). 1998. Investigation summary and analytical data tables for Area 3-360, North Boeing Field; report excerpts received from Boeing on 28 December 1998.

Environmental Resources Management (ERM). 1996. *Installation Restoration Program (IRP) Final Remedial Investigation/Feasibility Study Work Plan, 143rd Combat Communications Squadron, Seattle Air National Guard Station*. July 1996.

______________. 1998. *Installation Restoration Program (IRP) Final Phase I Remedial Investigation Report, 143rd Combat Communications Squadron, Seattle Air National Guard Station*. May 1998.

______________. 1999a. *Installation Restoration Program Final Phase II Remedial Investigation Report, 143rd Combat Communications Squadron, Seattle Air National Guard Station*. August 1999.

______________. 1999b. *Installation Restoration Program Final Phase II Feasibility Study Report, 143rd Combat Communications Squadron, Seattle Air National Guard Station*. August 1999.

Luzier, J.E. 1969. *Geology and Groundwater Resources of Northwestern King County, Washington*. Department of Conservation, Division of Water Resources.

Operational Technologies Corporation (OpTech). 1995. *Installation Restoration Program, Preliminary Assessment/Site Inspection Report, 143rd Combat Communications Squadron, Seattle Air National Guard Station.*

Puls, Robert W., and Michael J. Barcelona. 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. United States Environmental Protection Agency (USEPA) Office of Research and Development. Ground Water Issue. April 1996.

KCSlip4 41562

SEA408092

Washington State Department of Ecology (WDOE). 1996. *The Model Toxics Control Act Cleanup Regulation, Chapter 173-340 WAC.* Publication No. 94-06. Amended January 1996.

KCSlip4 41563

SEA408093

APPENDIX A

SITE SAFETY AND HEALTH PLAN

APPENDIX A

SITE SAFETY AND HEALTH PLAN

Emergency References

Key Telephone Numbers

AMBULANCE	911
POLICE	911
FIRE	911
HOSPITAL	911
NATIONAL RESPONSE CENTER	1-800-424-8802
POISON CONTROL CENTER	1-800-682-9211
TOXLINE	1-301-496-1131
CHEMTREC	1-800-424-9300
ENVIRONMENTAL RESOURCES MANAGEMENT (ERM), WALNUT CREEK OFFICE	1-925-946-0455
ERM, BELLEVUE OFFICE	1-425-462-8591
BASE SAFETY MANAGER	1-206-764-5608 SMS Dan Brewer

Nearest Hospital

Harborview Medical Center 325 Ninth Avenue Seattle, Washington	1-206-223-3074

KCSlip4 41565

SEA408095

Directions to Hospital (See Figure A-1)

Exit the Seattle Air National Guard Station (ANGS) through the main entrance. Turn right (north) onto Ellis Avenue. After one block, turn left (west) onto Warsaw Street. In one block, turn north onto Corson Avenue, and follow signed lanes to Interstate 5. Enter Interstate 5 Northbound. Exit Interstate 5 at the James Street Exit (Exit 164) and exit the collector/distributor on the James Street off-ramp. Turn right (east) on James Street, follow 2 blocks to 9th Avenue. Turn right on to 9th Avenue, Harborview Hospital is on the right.

ERM Representatives

PROJECT MANAGER	Robert Leet
SITE MANAGER	Don Wyll
SITE HEALTH AND SAFETY OFFICER	Don Wyll
DIRECTOR, HEALTH AND SAFETY	Steven Meyers, C.S.P., C.I.H.

KCSlip4 41566

SEA408096

FINAL

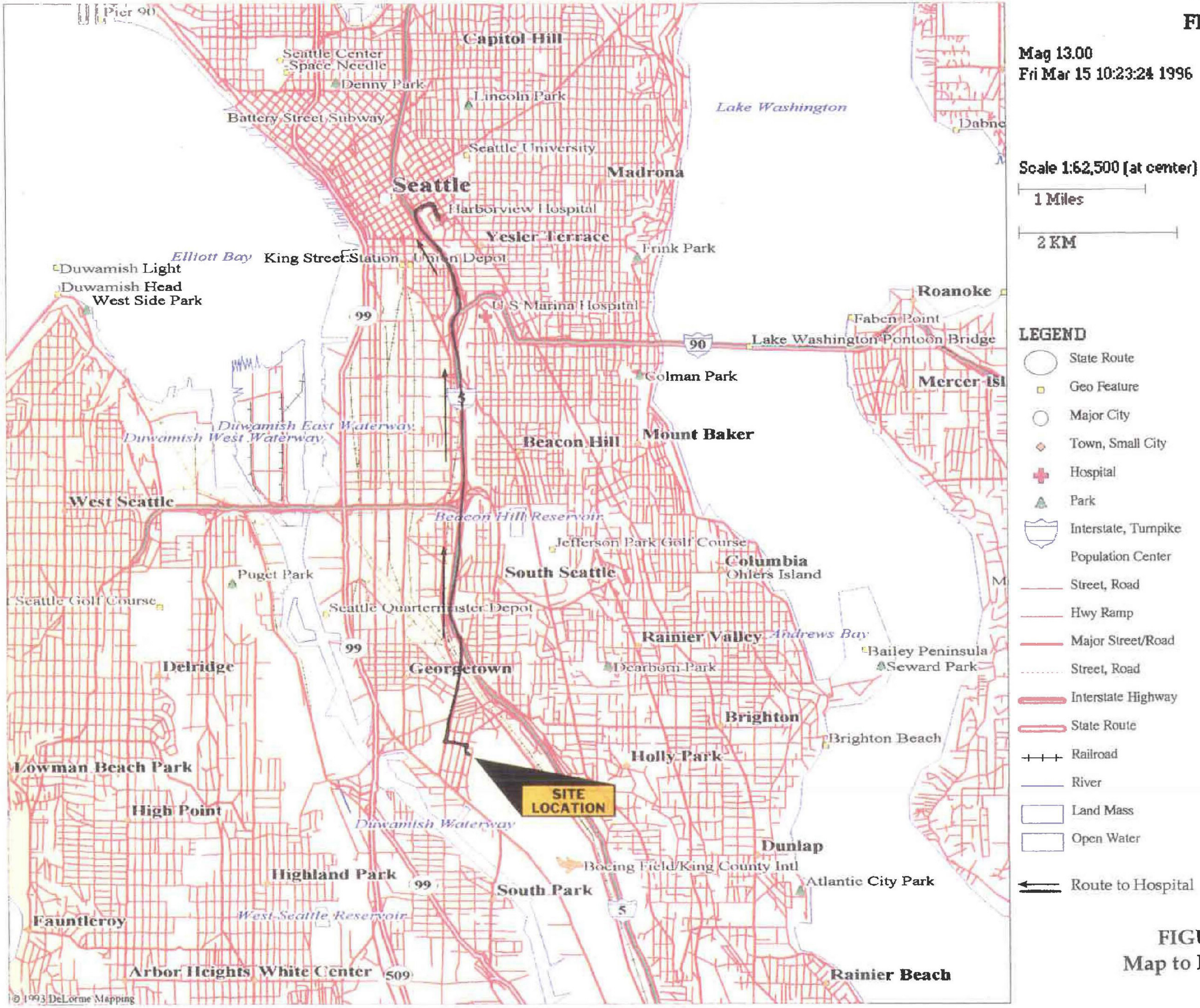


FIGURE A-1
Map to Hospital

KCSlip41567
SEA408097

EMERGENCY RESPONSE PLAN SUMMARY

In the event of a health or safety emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The Site Safety and Health Officer (SHO) will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in first aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during field operations. The ERM Project Manager and Site Manager shall be immediately informed of any serious injuries.

Additional emergency response and accident investigation procedures are detailed in Section 7.0 of this Safety and Health Plan.

General Evacuation Plan

In case of fire, explosion, or toxic vapor release, a site evacuation may be ordered by the SHO. The following procedure shall be followed in the event of an evacuation:

- Announce the evacuation via radio/horn and notify ANG personnel and others in site buildings, then immediately call 911;
- Evaluate the immediate situation and downwind direction. All personnel will evacuate in the upwind direction;
- All personnel will assemble in an upwind area when the situation permits, and a head count will be taken by the SHO; and
- Await the arrival of local qualified emergency response personnel.

KCSlip4 41568

SEA408098

First Aid

Qualified personnel on site shall give first aid and stabilize any worker needing assistance. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, call 911 and request emergency medical assistance.

A first-aid kit and emergency 16-ounce eyewash station shall be maintained readily accessible to all workers. The 16-ounce eyewash station should be supplemented by a nearby 15-minute eyewash station.

Emergency first aid for organic hazardous substances is outlined in Section 7.4 of this Safety and Health Plan.

Spills or Hazardous Material Releases

Spills or hazardous material releases that pose a potential threat to human health or the environment shall be reported to the appropriate authorities by the SHO. Small spills that do not pose a threat shall be reported to the SHO and will be addressed per the chemical manufactures' recommended procedures.

In the unlikely event of a significant release of hazardous material during field work, the proper state and local authorities will be immediately notified. Appropriate actions will be taken to protect the public and control the continued release or migration of the hazardous material.

Emergency Operation Shutdown Procedures

In the event that a hazardous situation develops on site, the SHO may temporarily suspend operations until the situation is corrected or controlled. The SHO will have the authority to restart operations when the situation as been corrected and safe working conditions have been restored.

KCSlip4 41569

SEA408099

DISCLAIMERS AND LIMITATIONS ON USE

Environmental Resources Management ("ERM") developed the following Sitewide Safety and Health Plan (the "SSHP") for use by ERM personnel and by ERM subcontractors (individually, an "ERM Contractor" and collectively, "ERM Contractors") in connection with soil and groundwater investigation, monitoring, and remediation activities (the "Project") being performed by ERM for the Air National Guard Readiness Center (the "Client") at the Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington (the "Site"). ERM personnel must adhere to the practices and procedures specified in the SSHP.

Each ERM Contractor must review the SSHP and agree to accept and abide by the SSHP, subject to any modifications to the SSHP (to address the ERM Contractor's more stringent practices and procedures) agreed upon in writing by ERM and the ERM Contractor. The ERM Contractor shall indicate such acceptance by executing a copy of this notice of disclaimers and limitations on use as indicated below and returning it to ERM's project manager for the Project prior to commencing work at the Site. However, if any ERM Contractor commences work at the Site, the ERM Contractor shall be deemed to have accepted the SSHP and the terms hereof and the failure to execute and return to ERM a copy of this notice shall not be relevant to such interpretation.

If a contractor or a person other than the Client, ERM employees and ERM Contractors (individually, a "Third Party" and collectively, "Third Parties") receives a copy of the SSHP, such Third Party should not assume that the SSHP is appropriate for the activities being conducted by the Third Party. NO THIRD PARTY HAS THE RIGHT TO RELY ON THE SSHP. EACH THIRD PARTY SHOULD ABIDE BY ITS OWN SSHP IN ACCORDANCE WITH ITS OWN PROFESSIONAL JUDGMENT AND ESTABLISHED PRACTICES.

ERM shall not be responsible for the implementation of any Third Party's safety program(s), except to the extent otherwise expressly agreed upon by ERM and a Third Party in writing. The services performed by ERM for the Client and any right of the Client and/or an ERM Contractor to rely on the SSHP shall in no way inure to the benefit of any Third Party, including, but not limited to, employees, agents, or consultants and subcontractors of ERM Contractors, so as to give rise to any cause of action by such Third Party against ERM.

KCSlip4 41570

SEA408100

The SSHP generated by ERM in connection with the Project is for use on a specific site and in connection with a specific project. ERM makes no representation or warranty as to the suitability of the SSHP for reuse on another site or as to the suitability of the SSHP for reuse on another project or for modifications made by the Client or a Third Party to the SSHP.

ERM Contractors Only

Agreed and Accepted By:

Contractor's Name: ______________________

By: ____

Title: ______________________________________

Date: ______________________________________

TABLE OF CONTENTS

KCSlip4 41572

SEA408102

TABLE OF CONTENTS

TABLE OF CONTENTS

KCSlip4 41574

SEA408104

LIST OF FIGURES

LIST OF TABLES

KCSlip4 41576

SEA408106

SECTION 1.0

INTRODUCTION

This Sitewide Safety and Health Plan (SSHP) has been developed by Environmental Resources Management (ERM) to establish the safety and health procedures required to minimize potential hazards to personnel who will be involved in soil and groundwater investigation, monitoring, and remediation activities planned for the Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington. The provisions of this SSHP directly apply to ERM personnel and contractors, if utilized, who will be potentially exposed to safety and/or health hazards related to the project. Based upon the guidelines specified in this SSHP, ERM will advise Air National Guard (ANG) personnel on the safety and health aspects of this project; however, this SSHP does not directly apply to ANG personnel.

The procedures in this SSHP have been developed based upon current knowledge regarding the specific chemical and physical hazards at the Station. This SSHP has been written to comply with the requirements of ERM's safety and health policies. It is ERM's policy that activities covered by this SSHP must be conducted in complete compliance with this SSHP and with all applicable federal, state, and local safety and health regulations, including the federal Occupational Safety and Health Administration (OSHA) Construction Industry Standards in 29 Code of Federal Regulations (CFR) 1910.120. On-site personnel who cannot, or will not, comply with these requirements will be excluded from project activities. Prior to the commencement of field activities, all ERM and subcontractor personnel covered by this SSHP must review this document and return the sign-off form to the Site Manager.

1.1 Site Description and History

This section discusses the general history and physiography of the Seattle ANGS including descriptions of site location and land use, identification of hazardous chemicals associated with site activities and known releases, and presentation of general site characteristics.

KCSlip4 41577

SEA408107

1.1.1 Location

The Seattle ANGS is located in the northwest corner of King County International Airport (also known as Boeing Field), Seattle, Washington. The Seattle ANGS, which is the headquarters for the 143rd Combat Communications Squadron (CCS), is located at 6736 Ellis Avenue South and currently occupies 7.5 acres. Boeing Field is located approximately 3 miles south of the Seattle central business district. Land use in the vicinity of the Seattle ANGS is industrial, residential, and commercial.

1.1.2 Operations History

Seattle ANGS was built during World War II by the War Department and was used during the war by the Army Air Force as the "Aircraft Factory School." In 1948, the property was transferred to King County as surplus property and was subsequently leased to the Washington ANG.

On 21 April 1948, the 143rd Aircraft Control and Warning Squadron was established. From May 1951 to February 1953, the 143rd was activated for recruitment purposes. During this period of time, the unit had two C-47 aircraft. In 1960, the name of the unit was formally changed to the 143rd Communication Squadron Tributary Teams. In 1969 and 1988, the name of the unit was again changed to the 143rd Mobile Communications Squadron and the 143rd CCS, respectively. The current mission of the 143rd CCS is to provide mobile communication equipment and support for airports and airfields.

In 1948, the Seattle ANGS consisted of 17 acres of land, including an aircraft parking ramp, leased from King County. At that time, the property contained 15 buildings (including a number of small shed structures), all of which were subsequently demolished. In 1951, a new property lease decreased the size of the ANGS from 17 acres to its present size of 7.5 acres, and buildings were constructed for headquarters, a mess hall, a warehouse, and vehicle service requirements.

In 1980, the National Guard Bureau and Congress funded $2.3 million for the replacement of all buildings at the Seattle ANGS. The buildings were completed in 1984, with the exception of the Mobility Warehouse, which was completed in 1988. Seattle ANGS now consists of 7.5 acres and four buildings with a total area of 34,698 square feet. The Seattle ANGS property is leased from King County by the United States Air Force, who then licensed the property to the Washington State Military Department for ANG use.

KCSlip4 41578

SEA408108

The operations of the 143rd CCS include ground vehicle maintenance; electrical maintenance; and petroleum, oil, and lubricants distribution and management. Significant quantities of gasoline, diesel fuel, and engine oil are used on the Seattle ANGS, as are smaller amounts of industrial solvents, antifreeze, paints, and acids. Typical wastes include contaminated fuels, spent solvents, off-specification materials, and refrigeration oils.

1.2 Prior Investigations

1.2.1 Preliminary Assessment and Site Inspection

A Preliminary Assessment/Site Inspection was completed by Operational Technologies Corporation (OpTech) between 1991 and 1995. OpTech completed a geophysical survey, soil gas survey, and three soil borings, and installed a total of 3 groundwater monitoring wells at Installation Restoration Program (IRP) Site 1 - Burial Site, which is officially considered an area of concern (AOC). The geophysical survey was completed using ground-penetrating radar and magnetometer methods to detect possible buried waste materials or containers in the AOC.

Beryllium and total petroleum hydrocarbons (TPH) were detected at concentrations greater than Model Toxics Control Act (MTCA) Cleanup Levels in soil samples collected by OpTech from the soil borings at IRP Site 1 - Burial Site. Beryllium was detected at a maximum concentration of 1.1 milligrams per kilogram. TPH was detected at a maximum concentration of 780 milligrams per kilogram. Gross alpha and gross beta analyses of soil samples indicated particle activities from 0 to 4 picoCuries per gram (pCi/g).

Arsenic, beryllium, chromium, and lead were detected at concentrations greater than MTCA Cleanup Levels in groundwater samples collected by OpTech from the monitoring wells at the IRP Site 1 - Burial Site AOC. The maximum concentrations detected in the groundwater samples were as follows: arsenic - 28 micrograms per liter (μg/l), beryllium - 820 μg/l, chromium - 97 μg/l, and lead - 26 μg/l. Gross alpha and gross beta analyses of groundwater samples indicated particle activities from 15 to 77 pCi/l. The MTCA Method A Cleanup Level for gross alpha activity is 15.0 pCi/l.

KCSlip4 41579

SEA408109

1.2.2 Phase I Remedial Investigation

During the Phase I Remedial Investigation (RI), the results of the soil and groundwater chemical analyses were compared to project screening goals (PSGs) developed for the Station. Based on this comparison, potential contaminants of concern (COCs) were identified in site soil and groundwater. Potential COCs include those constituents detected in at least one Phase I RI sample at concentrations above PSGs. Detections of constituents attributable to area background concentrations or suspected laboratory contamination (i.e., radionuclides, metals, and semivolatile organic compounds [SVOCs]) were excluded.

Potential COCs identified at the Seattle ANGS include:

Soil

- Trichloroethene (TCE)

Groundwater

- Benzene
- Toluene
- Ethylbenzene
- Xylenes
- Cis-1,2-dichloroethene
- 1,2-dichloroethane
- 1,1,1-trichloroethane
- TCE
- Acetone
- 1,3,5-trimethylbenzene
- Tetrachloroethene (PCE)

The distribution of volatile organic compounds (VOCs) detected in groundwater at the Station does not display any clear pattern to suggest the possible source(s). The Paint Storage Building (Building 203) may represent a source of the dissolved VOCs detected in "background" monitoring well BS-004PZ. However, the Phase I RI data were not sufficient to determine whether Building 203 or a different source may be present.

1.2.3 Phase II Remedial Investigation

During the Phase II RI, the results of the soil and groundwater chemical analyses were compared to PSGs developed for the Station. Based on this comparison, potential COCs were identified only in site groundwater.

Xylenes were detected in one direct-push boring location (GP-39); however, these concentrations were below PSGs. Detections of constituents attributable to area background concentrations or suspected laboratory contamination (i.e., radionuclides, metals, and SVOCs) were excluded.

Potential COCs identified at the Seattle ANGS include PCE and TCE in groundwater.

The distribution of VOCs detected in groundwater at the Station does not display any clear pattern indicating an on-site source for the VOCs. Available data suggests that the VOCs detected in groundwater in the southern portion of the Station may be related to VOCs detected in groundwater at Boeing Company site immediately to the south. Results from the Phase II RI suggests continued monitoring of the Seattle ANGS to analyze trends in VOC concentrations in groundwater and to verify compliance with Applicable or Relevant and Appropriate Requirements.

1.3 Investigation Work Plan

Four quarterly rounds of groundwater samples will be collected from each groundwater monitoring well for laboratory analysis.

Details regarding the activities conducted during the Phase II RI are discussed in the investigation work plan entitled *1998–2000 Groundwater Monitoring Workplan Seattle ANGS* (ERM 1999).

KCSlip4 41581

SEA408111

SECTION 2.0

KEY PERSONNEL

The organization and responsibilities for implementing safe project activities, and more specifically the requirements contained in this SSHP, are discussed in this section.

The key personnel for this project are:

PROJECT MANAGER	Robert Leet
SITE MANAGER	Don Wyll
SITE HEALTH AND SAFETY OFFICER	Don Wyll
DIRECTOR, HEALTH AND SAFETY	Steven Meyers, C.S.P., C.I.H.

2.1 Project and Site Manager

The ERM Project Manager is, by designation, the individual who has the primary responsibility for ensuring the overall safety and health of this project. The Site Manager has the primary responsibility for ensuring the SSHP is implemented in the field. The Site Manager's specific responsibilities include:

- Ensuring that all site project personnel have received, read and completed this SSHP;
- Requiring the attendance of all site personnel to a daily tailgate briefing (prior to performing work) apprising them of the contents of this SSHP and the specific hazards present at the facility;
- Ensuring that sufficient personal protective equipment (PPE), as required by this SSHP, is available during the project;
- Obtaining all subcontractor documentation of employee participation in a medical monitoring and health and safety training program;

- Maintaining a high level of safety and health consciousness among employees at the facility; and
- Maintaining regular communications with the Site Safety and Health Officer (SHO), the Project Manager, and, if necessary to resolve safety and health conflicts, the Director of Internal Safety and Health (DISH).

2.2 Site Safety and Health Officer

The appointed SHO will be a member of the ERM project field team. The SHO's responsibilities include enforcing the requirements of this SSHP once work begins. By design, the SHO has the authority to immediately correct all situations where noncompliance is noted and to immediately stop work in cases where an immediate danger is perceived. The SHO's specific responsibilities include:

- Procuring and distributing the PPE and air monitoring instrumentation needed for the project;
- Verifying that all PPE and safety and health equipment is in efficient working order;
- Setting up and maintaining the personnel decontamination facility;
- Controlling site entry of unauthorized personnel;
- Supervising and monitoring the safety performance of all personnel to ensure that required safety and health procedures are followed and correcting any deficiencies;
- Conducting accident/incident investigations and preparing investigation reports; and
- Initiating emergency response procedures.

2.3 Director of Internal Safety and Health

ERM's DISH is the individual responsible for the preparation, interpretation, and modification of this SSHP. Modifications to this SSHP, which may result in less stringent precautions, cannot be undertaken by the Project Manager, Site Manager, or SHO without the approval of the DISH. Specific responsibilities of the DISH include:

- Advising the Project Manager, Site Manager, and SHO on matters relating to safety and health on this project;
- Recommending appropriate PPE and air monitoring instrumentation to protect personnel from potential hazards present on site;
- Performing field audits, when necessary, to monitor the effectiveness of the SSHP and to ensure compliance;
- Conducting or directing personal exposure monitoring where required and where deemed necessary to determine the adequacy of protective measures and PPE specified by this SSHP;
- Maintaining contact with the Project Manager to regularly evaluate project conditions and new information that might require modification to this SSHP;
- Working with the Site Manager to ensure that sufficient PPE is available at the site; and
- Conducting briefing meetings, when necessary, to apprise personnel of the contents of this SSHP and the project hazards.

2.4 Field Personnel

All field and subcontractor personnel are responsible for following the safety and health procedures specified in this SSHP and for performing their work in a safe and responsible manner. Specific requirements include:

- Obtaining a copy of this SSHP and reading it, in its entirety, prior to the start of field activities;
- Signing the Safety and Health Signature Sheet acknowledging receipt and understanding of this SSHP;
- Exposing/voicing any questions or concerns (prior to the start of work) regarding the content of the SSHP to the SHO, Site Manager, Project Manager, or DISH;

KCSlip4 41584

SEA408114

- Reporting accidents/incidents and the presence of potentially hazardous working situations to the SHO and Site Manager; and
- Complying with the requests of the appointed SHO.

KCSlip4 41585

SEA408115

SECTION 3.0

PARTICIPANT QUALIFICATIONS

3.1 Training Requirements

All ERM field personnel working on the Seattle ANGS RI and Feasibility Study activities will have completed a 40-hour OSHA training course in Hazardous Waste Operations and Emergency Response (HAZWOPER), and will have previously worked at least 3 days at a hazardous waste site. The 40-hour OSHA training course must be designed to meet the requirements of 29 CFR 1920.120. In addition, field personnel who completed their 40-hour HAZWOPER training more than 1 year prior to the start of field activities will have completed an annual 8-hour refresher course.

All subcontractor personnel will be required to show proof of current OSHA HAZWOPER training (less than 1 year since initial or refresher training) prior to field activities. Personnel without current training documentation will be barred from site activities.

3.2 Medical Surveillance

All site workers will be required to have a written statement from a licensed physician stating they have had a medical examination which meets the requirements of 29 CFR 1910.120. This examination must include pulmonary function testing. All site workers must also be certified by a physician stating their ability to wear a negative-pressure respirator and to perform strenuous work. If a person sustains an injury or contracts an illness related to work on site that results in lost work time, he/she must obtain written approval from a physician to regain access to the site.

KCSlip4 41586

SEA408116

3.3 Record Keeping

Air monitoring via industrial hygiene monitoring or direct-reading instruments will become part of the written record. Medical and air monitoring data will be retained for 30 years. Training records will be maintained in project files and will be available for inspection at any time. Subcontractor training and medical surveillance certification will also be maintained in project files.

KCSlip4 41587

SEA408117

SECTION 4.0

HAZARD EVALUATION

4.1 Chemical Hazards

Based on data collected from soil and groundwater sampling at the site during the 1998 Phase II RI, the suspected chemical hazards at the Seattle ANGS are VOCs (primarily TCE and PCE). These substances exist in soil and groundwater at the site.

4.1.1 Volatile Organic Compounds

Most VOCs, except those known to be carcinogenic, exhibit similar health effects in humans. Effects on the central nervous and upper respiratory systems and skin irritation predominate. Therefore, although the hazards of several common VOCs are described separately below, the potential additive effects of multiple compounds were considered in determining air monitoring action levels.

TCE. TCE is a colorless, low-flammable liquid with a chloroform-like odor. It is toxic to the central nervous system and is also a carcinogen. Inhalation of TCE can cause narcosis, headache, drowsiness, hallucinations, and distorted perception. At high concentrations, inhalation can cause unconsciousness or death due to cardiac arrest. TCE vapor is irritating to the eyes, nose, respiratory tract, and skin. Chronic exposure may cause heart, liver, and kidney damage. The current OSHA and Washington State Time-Weighted Average (TWA) Permissible Exposure Limit (PEL) for TCE vapor is 50 parts per million (ppm). The short term (15-minute) exposure limit (STEL) is 200 ppm.

PCE. PCE is a colorless, non-combustible liquid with a mild, chloroform-like odor. It is toxic to the central nervous system and is also a carcinogen. Exposure to PCE can adversely effect functioning of the mucous membranes, eyes, lungs, liver, kidney, and heart. Common symptoms of exposure include dizziness, headache, light-headedness, and possibly unconsciousness. Skin contact may cause a dry, scaly, itchy dermatitis.

KCSlip4 41588

SEA408118

Recent studies suggest that PCE can cause liver cancer in rats and mice. The current OSHA and Washington State TWA PEL for PCE vapor is 25 ppm.

1,2-Dichloroethene (1,2-DCE). 1,2-DCE is a colorless, flammable liquid with a slightly acrid, chloroform-like odor. It is toxic to the central nervous system and is also a suspected human carcinogen. 1,2-DCE vapor is irritating to the eyes, nose, and respiratory tract. At high concentrations, it has caused liver and kidney damage in laboratory animals. The current OSHA TWA PEL for 1,2-DCE vapor is 200 ppm.

Xylene. Xylene is toxic to the central nervous system and is an eye, nose, throat, and skin irritant. Chronic exposure can cause damage to the gastrointestinal tract, blood, liver, and kidneys. The current OSHA and Washington State TWA PEL for xylene vapor is 100 ppm. The STEL is 150 ppm.

Table 4-1 provides a summary of the exposure information for the compounds identified above.

4.2 Physical Hazards

Physical hazards associated with site activities include slips, trips, falls, contact and crushing type injuries, eye abrasions, contusions, lacerations, flammability, and heat stress concerns. The potential for such hazards necessitates the use of safety shoes or boots, eye goggles or safety glasses, and hard hats. Additionally, personnel engaged in work activities with the potential for hand or finger injuries are to wear sturdy work gloves.

4.2.1 Use of Equipment

Any equipment, including vehicles, winches, or other machinery will be operated in strict compliance with the manufacturer's instructions, specifications, and limitations as well as any applicable regulations. The operator is responsible for inspecting the equipment daily to ensure that it is functioning properly and safely. This inspection will include all pins, pulleys, connections subject to accelerated wear, and all lubrication points.

When equipment with moving booms, arms, or masts are operated in the vicinity of overhead hazards, the operator, with assistance from the

FINAL

TABLE 4-1

Exposure Information for Selected Potential Site Compounds
143rd CCSQ, Seattle ANGS, Seattle, Washington

Compound	OSHA PEL/WA PEL/STEL (ppm)	Physical Description	Routes of Exposure	Symptoms of Exposure	Air Monitoring Instrument
TCE	50/50/200	Colorless liquid with a chloroform-like odor. Sometimes dyed blue.	Inh, Abs, Ing, Con	Headache, vertigo; visual distortion, tremors, nausea, vomiting; eye and skin irritation; cardiac arrhythmia.	PID/FID
PCE	25/25/None	Colorless liquid with a mild, chloroform-like odor.	Inh, Ing, Con	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo, dizziness, incoherence; headache.	PID/FID
Xylene	100/100/150	Colorless liquid with an aromatic odor.	Inh, Abs, Ing, Con	CNS depression; skin, eye, nose, and throat irritation; nausea, vomiting.	PID/FID
cis-1,2-DCE	200/None/None	Colorless liquid with a slightly acrid, chloroform-like odor.	Inh, Ing, Con	CNS depression; eye and respiratory system irritation.	PID/FID

Notes:
ppm = Parts per million
Inh = Inhalation
Ing = Ingestion
Con = Skin and/or eye contact
Abs = Skin absorption
PID = Photoionization detector
FID = Flame ionization detector

OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure limit
STEL = Short Term Exposure Limit
WA = Washington
TCE = Trichloroethene
PCE = Tetrachloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene

designated signaling person, will ensure that the moving parts of the equipment maintain safe clearances to the hazards. Equipment will be kept at least 20 feet away from energized electrical lines.

All portable equipment and tools will be inspected prior to each day's use and as often as necessary to ensure they are safe to use. Defective equipment and tools will be removed from service immediately. Examples of defective tools include: hooks and chains stretched beyond allowable deformations; cables and ropes with more than the allowable number of broken strands; missing grounding prongs on power tools; defective on/off switches; mushroomed heads of impact tools; sprung wrench jaws; and missing or broken handles or guards as well as wooden handles which are cracked, splintered, or loose. All equipment and tools will be used within their rated capacities and capabilities.

4.2.2 Flammability Hazards

Due to the nature of this project, the hazards associated with flammability are expected to be low. However, the following good management practices shall apply at the site.

All electrical equipment used during the project will be inspected to ensure that it is in good repair and has no frayed or loose connections before use. Only approved, listed equipment and components will be used. All connections will be made in accordance with National Electric Code practices. All equipment and devices so designed will be properly grounded or bonded to an adequate grounding mechanism. Although explosive limits are not expected, only equipment listed as explosion proof will be used in areas where explosivity is sustained at or above 5 percent of the Lower Exposure Limit.

4.2.3 Heat Stress Concerns

Heat stress is the combination of both environmental and physical work factors that contribute to the total heat load imposed on the body. Environmental factors that contribute to heat stress include air temperature, radiant heat exchange, air movement, and humidity.

The body's response to heat stress is reflected in the degree of symptoms. When heat stress is excessive for the exposed individual, a feeling of discomfort or distress may result and a heat-related disorder may ensue. The severity of the response will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat stress is a general term used to describe one or more of the following heat-related disabilities and illnesses.

Heat Cramps. Painful, intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Cramps usually occur after heavy sweating and often begin at the end of a work shift.

Heat Exhaustion. Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.

Heat Stroke. Sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical attention is needed immediately.

Workers will be trained on the signs and symptoms of the forms of heat stress and will be encouraged to monitor themselves and others. In addition, experience has shown that the following work/rest regimen is appropriate for field workers performing various degrees of work while wearing Level D PPE (all values are given in degrees Celsius (°C) Wet Bulb Globe Temperature [WBGT]):

	Work Load		
Work/Rest Regimen	**Light**	**Moderate**	**Heavy**
Continuous Work	30.0	26.7	25.0
75% work/25% rest each hour	30.6	28.0	25.9
50% work/50% rest each hour	31.4	29.4	27.9
25% work/75% rest each hour	32.2	31.1	30.0

KCSlip4 41592

SEA408122

WBGT is defined according to the following formula (outdoors with solar load) where WB, GT, and DB are the wet bulb, globe, and dry bulb temperatures, respectively:

$$WBGT = 0.7WB + 0.2GT + 0.1DB$$

The workload classes are defined in The American Conference of Governmental Industrial Hygienists booklet, *Threshold Limit Values and Biological Exposure Indices for 1995-1996.*

4.2.4 Cold Stress Concerns

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. Cold stress (hypothermia) and cold injury can be avoided by preventing a fall in the deep core temperature of the body.

A symptom of hypothermia is an increased metabolic rate. This is the body's attempt to compensate for the heat loss and shivering. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36 °C (96.8 degrees Fahrenheit [°F]). Lower body temperatures can result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of cold stress. During exposure to cold, maximum severe shivering develops when the body's temperature has fallen to 35 °C (95 °F). **Exposure to cold shall be immediately terminated for any worker when severe shivering becomes evident.**

The body must be protected from exposure to cold air temperatures via whole body protection:

- Adequate insulating clothing must be provided to workers if work is performed in air temperatures below 40 °F.
- Older workers or workers with circulatory problems must be provided with extra insulating clothing and/or a reduction in the duration of exposure.
- Gloves shall be used by all workers if the air temperature falls below 40 °F.

To prevent frostbite, workers should wear insulated gloves when in contact with surfaces below 20 °F. Mittens are required if the air temperature falls below 0 °F.

If insulated clothing is not adequate to prevent sensations of excessive cold or frostbite, auxiliary heaters or suspension of work is required.

EXPOSURE MONITORING PLAN

5.1 Area and Personal Monitoring

Air monitoring will be conducted to determine the presence of on-site hazardous conditions and will help determine the level of personal protection required for personnel. Environmental monitoring equipment will include a photoionization detector (PID) or a flame ionization detector (FID) for volatile organics and, if necessary, a Mini-RAM for dusts. Characterization of these instruments will determine airborne contaminants present and their concentrations in the workplace and will help assess worker safety.

5.1.1 General Area Monitoring

Area air monitoring will be conducted during all field work. The intent is to utilize generic field instruments and action levels to assess the continuous exposure to field personnel during the investigation, and to upgrade or downgrade PPE in response to the monitoring. The general monitoring shall consist of daily breathing zone monitoring every 30 minutes using the PID or FID and Mini-RAM (if applicable). In addition, upon unlocking each monitoring well, the well headspace will be monitored using a PID or FID. Daily calibration checks and maintenance of the PID or FID and Mini-RAM will also be recorded and performed according to the manufacturer's recommendations (see Appendix A for calibration documentation sheet). Breathing zone readings will be recorded in the field log book.

5.2 Action Levels

The SHO will establish daily background total organic vapor (TOV) levels (and dust levels, if necessary) prior to initiating site activities. Under most circumstances, these levels can be determined by taking multiple readings at representative locations along the perimeter of the site and averaging the results of sustained measurements.

Decisions to upgrade or downgrade personal protection will be based on sustained breathing zone TOV and/or dust levels that exceed background levels, as well as applicable regulatory exposure limits. Breathing zone refers to the area from the top of the shoulders to the top of the head. Specific criteria for upgrading or downgrading personal protection based on TOV and dust levels are presented in the following table.

Sustained Breathing Zone TOV ppm and dust milligrams/meter (mg/m^3)	**Level of Protection**
Background + 5 ppm Background + 0.5 mg/m^3	**Level-D** (no respiratory protection)
5 ppm to 20 ppm 0.5 mg/m^3 to 2.5 mg/m^3	**Level-C w/ half-face respirator** (half face air-purifying respirator [APR] equipped with organic vapor/high efficiency particulate air [HEPA] cartridges)
20 ppm to 50 ppm 2.5 mg/m^3 to 5.0 mg/m^3	**Level-C w/ full-face respirator** (full-face APR equipped with organic vapor/HEPA cartridges)
Above 50 ppm or 5.0 mg/m^3	**Level-B** (supplied-air respirators)

GENERAL SAFE WORK PROCEDURES

6.1 Personal Protection

In addition to the respiratory protection described in Section 5.0, the minimum PPE available on site shall include chemical resistant coveralls, hard hats, eye protection (i.e., safety glasses), ear plugs, inner latex or polyvinyl chloride gloves, outer nitrile gloves, and safety boots. It is expected that the highest level of protection that may be needed during field investigation activities will be Level C, which consists of the following:

- Full length shirt and long pants;
- Steel-toed boots or safety shoes;
- Safety glasses;
- Hard hat;
- Air-purifying respirator equipped with appropriate filter cartridges;
- Chemical resistant clothing (i.e., Tyvek, poly-coated Tyvek or Saranax suits). Suits are to be one-piece with attached hoods and elastic wrist bands;
- Outer chemical resistant gloves and inner latex surgical gloves; and
- Chemical-resistant overboots.

6.2 Work Zones and Decontamination Procedures

Work zones and decontamination procedures will be established in accordance with guidance provided in Chapters 9 and 10 of the NIOSH/OSHA/USCG/EPA document *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.* Where applicable, the exclusion zones will be marked with yellow caution tape. The location of the zones may be modified to fit applicable field conditions; however, proposed modifications must be approved by the SHO.

If necessary, a minimum two-basin wash/rinse station will be placed in the contamination/reduction zone to facilitate cleaning and removal of PPE. The wash/rinse station will be used by workers to clean and rinse boots and gloves. The ground beneath these basins will be covered with plastic to ensure the ground is not contaminated with basin wash/rinse water. A drum or other container will be designated to dispose of PPE that will not be reused.

It is expected that the highest level of protection used during project investigation activities will be Level C. Based on the level of expected exposure to chemical constituents, some or all of the following personnel decontamination procedures will be used as necessary:

- **Station 1: Equipment Drop** - Deposit equipment used on site (i.e., tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop station reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.

- **Station 2: Outer Garment, Boots, and Gloves Wash and Rinse** - Scrub outer boots and gloves, and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.

- **Station 3: Outer Boot and Glove Removal** - Remove outer boots and gloves. Deposit in container with plastic liner.

- **Station 4: Canister or Mask Change** – Exchange worker's canister, don new outer gloves and boot covers, tape joints, and worker returns to duty. If worker leaves the exclusion zone to change canister (or mask), this is the last step in the decontamination procedure.

- **Station 5: Boots, Gloves, and Outer Garment Removal** – Remove and deposit boots, chemical-resistant splash suit, and inner gloves in separate containers lined with plastic.

- **Station 6: Face Piece Removal** - Face piece is removed. Avoid touching face with fingers. Face piece is deposited on plastic sheet.

- **Station 7: Field Wash** - Hands and face are thoroughly washed. Shower if body contamination is suspected.

During decontamination, all personnel must follow the appropriate order for cleansing and removing: boots, outer gloves, coveralls or protective suit, respirators, and inner gloves. Direct contact with contaminated PPE can be avoided by a proper decontamination sequence. Respirators, if used, are not to be removed before leaving the contaminated area to avoid a potential inhalation hazard during decontamination.

Water, soap, and paper towels will be available for cleaning of the hands and face before breaks, eating, drinking, or smoking.

6.3 General Safety Rules

In addition to the specific requirements of this SSHP, common sense should prevail at all times. The following general safety rules and practices will be in effect at the site.

- The site will be suitably marked or barricaded as necessary to prevent unauthorized visitors. These barricades will not hinder emergency services, if needed.

- All open holes, excavations, trenches, and obstacles will be properly barricaded in accordance with local site needs. These needs will be determined by proximity to traffic ways, both pedestrian and vehicular, and site of the hole, trench, or obstacle. If holes are required to be left open during nonworking hours, they will be adequately decked over or barricaded and sufficiently lighted.

- Prior to conducting any digging or boring operations, underground utility locations will be identified. The site representative and local utility authorities (or Underground Alert) will be contacted to provide locations of underground utility lines and product piping. All boring, excavation, and other site work will be planned and performed with consideration for underground lines.

- Smoking and ignition sources in the vicinity of flammable or contaminated material is prohibited. Designated smoking areas will be delineated.

- Drilling, boring, movement and use of cranes and drilling rigs, erection of towers, movement of vehicles and equipment, as well as other activities will be planned and performed with consideration for the location, height, and relative position of aboveground utilities and fixtures. These fixtures include signs, lights, canopies, buildings, other structures, and construction, as well as natural features such as trees, boulders, bodies of water, and terrain.

- When working in areas where flammable vapors may be present, particular care must be exercised with tools and equipment that may be sources of ignition. All tools and equipment must be properly bonded and/or grounded.

- Individuals with beards that interfere with respirator fit are not allowed within the exclusion zone. This is necessary because all site personnel may be called upon to use respirator protection in some situations, and beards do not allow for a proper respirator fit.

- No smoking, eating, or drinking will be allowed in the contaminated areas.

- Tools and hands must be kept away from the face.

- Personnel should shower as soon as possible after leaving the site.

- Each environmental sample must be treated and handled as though it were extremely toxic.

- Do not touch obvious contaminated materials. Avoiding contact with these materials will facilitate decontamination.

- Persons with long hair and/or loose-fitting clothing that could become entangled in power equipment are not permitted in the work area.

- Horseplay is prohibited in the work area. The SHO has the authority to discharge site personnel for horseplay.

- Work while under the influence of intoxicants, narcotics, or controlled substances is prohibited.

Prior to the commencement of each day's activities, the SHO will conduct a daily tailgate safety meeting outlining new or potential hazards that may be encountered during site operations. The daily tailgate safety meetings will be documented by completion of the appropriate form located in the Attachment to this document.

SECTION 7.0

EMERGENCY RESPONSE/ACCIDENT INVESTIGATION

The phone numbers of the police and fire departments, ambulance service, local hospital, and ERM representatives are provided on the reference sheet at the front of this SSHP. Directions to the hospital are also provided on the sheet.

In the event of a health or safety emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The SHO will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in first aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during operations. The ERM Project Manager and Site Manager shall be immediately informed of any serious injuries.

Any accident/incident resulting in an OSHA recordable injury or illness, treatment at a hospital or physician's office, property damage, or a near miss accident, requires that an accident/incident report be completed and submitted to the ERM DISH. The investigation will be initiated as soon as emergency conditions are under control. The purpose of this investigation is not to assign blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided.

7.1 Planning

Prior to facility entrance, the SHO shall plan emergency actions and discuss them with personnel conducting project work. Initial planning includes establishing the best means for evacuation from the area in case of a catastrophe.

7.2 Emergency Services

A tested system must exist for rapid and clear distress communications, preferably voice, from all personnel to the SHO. Prior to commencing any facility investigation or operations, the SHO shall ensure that all personnel working at the facility know how to communicate with the appropriate local emergency response units, as well as provide adequate and clear directions between work locations and the locations of support personnel. Emergency response contacts and telephone numbers are included on the emergency reference sheet.

7.3 General Evacuation Plan

Should a site evacuation be ordered due to fire, explosion, or toxic vapor release, the SHO will:

- Announce the evacuation via radio/horn and notify ANG personnel and others in site buildings, then immediately call 911;
- Evaluate the immediate situation and downwind direction. All personnel will evacuate in the upwind direction;
- All personnel will assemble in an upwind area when the situation permits, and a head count will be taken by the SHO; and
- Await the arrival of qualified local emergency response personnel.

7.4 First Aid

Qualified personnel on site shall give first aid and stabilize any worker(s) needing assistance. Life support techniques such as cardiopulmonary resuscitation and treatment of life-threatening problems (such as bleeding, airway maintenance, and shock) shall be given top priority. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, call 911 and request emergency medical assistance.

A first-aid kit and emergency 16-ounce eye wash station shall be maintained readily accessible to all workers. The 16-ounce eyewash station should be supplemented by a nearby 15-minute eyewash station. Prior arrangements must be made to facilitate easy access (preferably within 10 seconds of the work area) to this 15-minute eyewash station.

Emergency first aid for organic compounds is outlined below.

7.4.1 Eyes

Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. If injury occurs or irritation persists, transport the worker(s) to a hospital emergency room as soon as possible.

7.4.2 Skin

Wash skin thoroughly with soap and water. See a doctor if any unusual signs, symptoms, or skin irritation occurs. Launder chemically-impacted clothing.

7.4.3 Inhalation

Move exposed person to fresh air. If breathing has stopped, apply artificial respiration. Call 911 immediately.

7.4.4 Ingestion

If hazardous chemicals are swallowed, DO NOT make person vomit. Call Poison Control Center immediately.

7.5 Fire Protection and Response

To ensure that fire and explosion hazards are minimized, field procedures involving potential fire/explosion hazards must be coordinated with the local Fire Department. Call 911 in the event of any fire at a work location. At least one fire extinguisher with a minimum class rating of 20BC shall be provided within 50 feet of the site activities. The fire extinguisher will be inspected annually at a minimum, and the inspections will be documented on an attached fire extinguisher inspection tag.

Potential fire sources/flammable materials that may be present on site during field work include gasoline and/or diesel stored in vehicle fuel tanks, portable generator fuel tanks, and small fuel cans (for refueling portable generators). In addition, small quantities of methanol will be used for sampling equipment decontamination. Containers for flammable materials will be inspected for possible leaks or overfills at least once per day. Corrective actions will be taken as necessary to repair or replace leaking containers or to clean overfill residual from the outside of containers. Care will be taken to keep flammable materials away from potential ignition sources.

7.6 Site Control Measures

The site control measures listed below are to be followed to minimize the potential contamination of workers, protect the public form potential site hazards, and control site access.

Barricades and barricade tape will be used to delineate an exclusion zone around drilling areas. An opening in the barricades upwind of the equipment will serve as an entry/exit point. A personnel decontamination station will be established at this point. All access to the drilling location will be made at the entry/exit point.

The site will be barricaded or otherwise made secure at the end of each workday. Soils will be drummed or placed on plastic and covered. Decontamination fluids will be drummed and properly labeled.

The SHO will log all site visitors in the field notebook and will ensure that all personnel entering the work zone are briefed on site activities and potential hazards.

7.7 Site Operation Zones

The following three Site Operation Zones will be established at each investigation site:

- Exclusion zone;
- Contamination reduction zone; and
- Support zone.

The exclusion zone includes areas of active investigation or cleanup. Prescribed levels of protection must be worn by all personnel within the exclusion zone. The boundary of the exclusion zone should be a well defined physical or geographical barrier.

The contamination reduction zone serves to prevent the transfer of hazardous materials picked up on personnel or equipment in the exclusion zone.

The support zone is the outermost area and is considered a non-contaminated area. The field operations command post, first aid station, and any other investigation support areas are located in the support zone. Potentially contaminated equipment is not allowed in this area.

7.8 Emergency Operation Shutdown Procedures

In the event that an extremely hazardous situation develops on site, the SHO may temporarily suspend operations until the situation is corrected or controlled. The SHO will have the authority to restart operations when the situation as been corrected and safe working conditions have been restored.

7.9 Spill or Hazardous Material Release

Spills or hazardous material releases resulting in human exposure or off-site environmental contamination are reported to the appropriate authorities by the SHO. Small spills are reported to the SHO and are taken care of per the chemical manufactures' recommended procedures.

7.10 Community Safety

Release or off-site migration of contaminants during field operations is unlikely. However, in the event of a significant release of contaminants during field work, the proper state and local authorities will be immediately notified. Appropriate actions will be taken to protect the public and control the contaminant release or migration.

ATTACHMENT 1

SAFETY AND HEALTH FORMS

The following signatures indicate that the Safety and Health Program has been read and accepted by ERM management and personnel as well as all contractors and subcontractors and their personnel.

NAME	TITLE	COMPANY	SIGNATURE	DATE

KCSlip4 41607

SEA408137

SUPERVISOR'S ACCIDENT/INCIDENT INVESTIGATION REPORT

Injured Employee:	Title:	
Date of Accident/Incident:	Dept.:	
Location:	Time on this Job:	
Engaged in what work when injured:		
Nature of accident/incident:		
How did accident/incident occur?		
What can be done to prevent recurrence of the accident?		
What has been done to prevent recurrence of the accident?		
Supervisor's Signature:	Dept.:	Date:
Reviewer's Signature:	Dept.:	Date:
NOTE: To be submitted to the Safety and Health Manager within 2 days of the accident/incident.		

ERM
DAILY TAILGATE SAFETY MEETING FORM

DATE:__________ TIME:______________ JOB NUMBER:______________

PROJECT NAME: ____

SPECIFIC LOCATION: ____________________________________

TYPE OF WORK: ____

CHEMICALS PRESENT: ____________________________________

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: ______________________________

Hazards of Chemicals Present: ______________________________

Physical Hazards: ____

Emergency Procedures: ___________________________________

Hospital/Clinic:____________ Phone: ____________ Paramedics: _____

Hospital Address: _______________________________________

Special Hazards: ____

Other Topics: ____

ATTENDEES

Name (printed)	Signature

KCSlip4 41609

SEA408139

ATTACHMENT 2

MATERIAL SAFETY DATA SHEETS

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
Renton, WA 98055
Phone: 425-277-9244
Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

MSDS Number: 1855
Revision Date: 17-Apr-97
Revision No.: 001

Product Identification

Product Name:	ISOPROPYL ALCOHOL
Synonyms:	Isopropanol, IPA, 2-Propanol
Chemical Formula:	CH3CHOHCH3
Formula Weight:	F.W. 60.10
Chemical Family:	Alcohol
Integra Product Numbers:	I855.10; I855.13; I855.15; I855.19; I855.31; I855.50

Hazard Overview

HMIS Rating: 1-3-2-G   NFPA Rating: 1-3-0

Warning Label:

DANGER!

Highly flammable liquid. Keep away from heat, sparks and open flame. Harmful if swallowed or inhaled. Use only with adequate ventilation. Avoid contact with skin, eyes and clothing. Wash thoroughly after handling.

Components

Component	CAS #	%
Isopropyl alcohol	00067-63-0	100

Physical Data

Boiling Point:	82 °C	Specific Gravity:	0.7854 Water=1
Melting Point:	-88.5 °C	Evaporation Rate:	2.5 Butyl Acetate=1
Vapor Pressure	33 mm Hg@20°C	Vapor Density:	2.07 Air = 1

Solubility:

Miscible with water, alcohol, ether and chloroform. Insoluble in salt solutions.

Appearance and Odor:

Clear, colorless liquid. Medicinal alcoholic odor

Fire and Explosion Data

Flash Point: 53 °F   Test Method: TCC

Auto-ignition Temperature: 750 °F

Flammable Limits (% by volume in air   Upper: 12.7   Lower: 2

Fire Extinguishing Media:

CO2, Dry chemical or alcohol foam. Water may be ineffective.

Special Firefighting Procedures:

Use water to cool nearby containers and structures. Wear full protective equipment, including suitable respiratory protection.

Unusual Fire and Explosion Hazards:

Vapors may flow along surfaces to distant ignition sources and flash back.

Health Hazard Information

Effects of Overexposure

Skin Contact:

May cause skin irritation. Prolonged contact may cause dermatitis.

Eye Contact:

May irritate or burn the eyes.

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
Renton, WA 98055
Phone: 425-277-9244
Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

MSDS Number: 1855
Revision Date: 17-Apr-97
Revision No.: 001

Health Hazard Information

Ingestion:

May be harmful if swallowed. Swallowing large quantities causes headaches, nausea, vomiting, stomach cramps, diarrhea and unconsciousness.

Inhalation:

Inhalation may irritate the nose, throat and upper respiratory tract. Inhalation of high concentrations may cause headache, nausea, dizziness, drowsiness, narcosis, CNS depression, difficulty in breathing. Very high concentrations may lead to pulmonary edema and unconscousness.

Chronic Effects of Overexposure:

None Identified

Exposure Limits:

		OSHA PEL	
	TWA	*STEL*	*Ceiling*
Isopropyl alcohol	400 ppm	NE	NE
		ACGIH TLV	
	TWA	*STEL*	*Ceiling*
Isopropyl alcohol	400 ppm	500 ppm	NE

Toxicity Data:

Isopropyl alcohol	LD50 (intraperitoneal, mouse)	933 mg/kg
	LC50 (inhalation, rat)	16000 ppm/8H
	LD50 (oral, rat)	5840 mg/kg
	LD50 (skin, rabbit)	13 g/kg

Medical Conditions Generally Aggravated by Exposure:

Skin disorders, eye disorders and respiratory system disease.

Target Organs:

Respiratory system, eyes, skin and central nervous system.

Reproductive Effects:

None Identified

Carcinogenicity:

None Identified

Component	NTP Listing	IARC Listing	OSHA Regulated
Isopropyl alcohol	No listing	No Listing	

Emergency First Aid Procedures

Skin Contact:

Wash with soap and water. Seek medical attention if irritation develops.

Eye Contact:

Flush with water for at least 15 minutes. Seek immediate medical attention.

Inhalation:

Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult administer oxygen. Seek medical attention.

Ingestion:

Give victim large amounts of water and induce vomiting. Never give anything by mouth to an unconscious or convulsing person. Seek immediate medical attention.

Additional First aid and Treatment Notes:

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
Renton, WA 98055
Phone: 425-277-9244
Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

Emergency First Aid Procedures

No information available.

Reactivity Data

Stability: Stable
Hazardous Polymerization: Will Not Occur

Incompatibles:

Incompatible with strong acids and strong oxidizers. Aldehydes, amines, halogen compounds, reactive metals

Decomposition Products:

Oxides of carbon (CO, CO_2)

Conditions to Avoid:

Heat, sparks and open flame.

Spill and Disposal Procedures

Spill and Leak Procedures:

Prevent spread of spill. Absorb with sand or inert material. Sweep or scoop into a disposal container. Flush spill area with water. Eliminate all possible ignition sources. Ground all material handling equipment. Wear full protective equipment, including suitable respiratory protection.

Disposal Procedures:

Dispose in accordance with all Local, State and Federal regulations. EPA Hazardous Waste Number: D001 (ignitable waste)

Protective Equipment

Ventilation:

Use general or local exhaust ventilation to meet TLV and PEL requirements.

Respiratory Protection:

If ventilation controls do not limit airborne concentrations below PEL or TLV values, an approved respirator must be worn. Use a chemical cartridge respirator with an organic vapor cartridge.

Skin and Eye Protective Equipment:

Safety goggles, protective clothing and gloves. Maintain an eyewash station and safety shower nearby.

Storage and Handling Precautions

Storage Area: FLAMMABLE LIQUID

Store in a cool, dry, well-ventilated flammable liquids storage area or cabinet. Protect containers from physical damage. Bond and ground containers when transferring liquid.

Transportation Information

☑ *Regulated Material domestic ground transportation*
(reference: CFR Title 49, Transportation)

Proper Shipping Name: Isopropanol
UN or NA Identification number: UN1219 Hazard Class and Label: 3 Flammable Liquid
Packing Group: II Subsidiary Risk and Label:

☑ *Regulated Material via Air Transportation*
(reference: ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air)

KCSlip4 41613

SEA408143

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
Renton, WA 98055
Phone: 425-277-9244
Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

MSDS Number: 1855
Revision Date: 17-Apr-97
Revision No.: 001

Transportation Information

Proper Shipping Name: Isopropanol
UN Identification Number: UN1219 Hazard Class and Label: 3 Flammable Liquid
Packing Group: II Subsidiary Risk and Label:

	Packing Instruction	Max net qty per package
Passenger Aircraft:	305/Y305	5/1 L
Cargo Aircraft:	307	60 L

Regulatory Information

Component	TSCA Inventory	CERCLA RQ	SARA EHS TPQ	SARA 313 Toxic Release *de minimus*
Isopropyl alcohol	☑	lbs	☐ lbs	✔ 0.1 lbs

SARA Hazard Categories:	Acute	Chronic	Flammability	Pressure	Reactivity
Isopropyl alcohol	☑	☑	☑	☐	

Clean Air Act Categories:	SOCMI	HAP	Volatile HAP	Organic HAP	Ozone Depleting
Isopropyl alcohol	☐	☐	☐	☐	

NE = Not established, NA = Not applicable or Not available

The information presented above is offered for informational purposes only. This MSDS, and the associated product is intended for use only b technically qualified persons, and at their own discretion and risk. Since conditions and manner of use are outside the control of Integra Chemic Company, we make no warranties, either expressed or implied, and assume no liability in connection with any use of this information.

****** END OF MSDS ******

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

39

Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).

Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA
2
2 0
-

HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec. 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)
Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1.53 kg/m^3
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC	Autoignition Temperature: 788 °F (420 °C)	LEL: 8% (25 °C); 12.5% (100 °C)	UEL: 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). ***Summary of Risks:*** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

Copyright © 1992 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
DOT Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

Copyright © 1992 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

KCSlip4 41621

SEA408151

LIST OF FIGURES

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

This document serves as the site-specific Quality Assurance Project Plan (QAPP) for Phase II Remedial Investigation (RI) and Feasibility Study (FS) activities at the Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington.

1.1 Plan Description

This QAPP presents the overall policies, data quality objectives (DQOs), specific quality assurance (QA) and quality control (QC) requirements, procedures, responsibilities, chain-of-custody procedures, laboratory analyses, and documentation that will be employed during Phase II RI/FS activities at the Seattle ANGS.

1.2 Remedial Investigation/Feasibility Study Description

The purpose of the RI (Phases I and II) is to provide an accurate, precise, and representative summary of the current vertical and horizontal extent of contamination in soil and groundwater associated with IRP Site 1 - Burial Site. Data obtained during the RI will be used during the FS phase as the scientific basis for identifying and selecting the most appropriate remedial alternatives for the site. This QAPP provides information regarding data collection and QA procedures to ensure that the data obtained during Phase II RI/FS activities are valid and usable for the FS decision process. The QAPP for the Phase I RI/FS is contained in *Installation Restoration Program (IRP) Final Remedial Investigation/Feasibility Study Work Plan, 143rd Combat Communications Squadron, Seattle Air National Guard Station, Seattle, Washington* (ERM, July 1996).

KCSlip4 41623

SEA408153

1.3 Remedial Investigation/Feasibility Study Project Objectives

The purpose of the QAPP is to establish standard procedures to ensure that the integrity, accuracy, precision, completeness, and representativeness of the samples are maintained in order to support the objectives of the RI/FS. The specific objectives of the RI/FS are as follows:

- Provide data to assist in defining the vertical and horizontal extent and magnitude of soil and groundwater contamination at the investigated site.
- Define site physical features, facilities, and hydrogeologic conditions that could affect contaminant migration, containment, or cleanup.
- Determine the nature and extent of potential threats to human health and the environment.
- Determine the types of response actions to be considered (decision document, FS, remedial design, or remedial action).
- Develop, screen, and evaluate remedial alternatives.
- Recommend the most cost-effective remedial alternatives that adequately protect human health, welfare, and the environment.

1.3.1 Data Usage

The data collected during the RI will provide the basis for decisions regarding remedial measures to ensure that concentrations of identified contaminants comply with applicable state and federal requirements. Specifically, the data collected during the RI will be used to:

- Characterize on-site sources of contamination;
- Determine the nature and extent of contamination and migration/exposure pathways; and
- Support the selection of cost-effective remedial technologies and alternatives.

1.3.2 Data Quality Objectives

DQOs are quantitative and qualitative objectives for ensuring that data of known and appropriate quality are obtained during the RI/FS to support the selection of appropriate remedial actions. DQOs are selected based on the specific use of the data collected.

1.3.3 Integration of DQOs

DQOs were developed through a three-stage process. The DQO process is an integral part of work plan development that includes field screening and sampling, sample shipment to the analytical laboratory, sample analysis, and reporting. The DQO process will be revised, as needed, based on the results of each data collection activity. The general DQO development process is outlined on Table B-1.

TABLE B-1

DQO Three-Stage Development
143rd CCSQ, Seattle ANGS, Seattle, Washington

STAGE	DESCRIPTION
1	Stage 1 of the DQO process identifies the individuals responsible for decisions, data uses, and available data; and determines if additional data is needed and the types of decisions that will be made regarding site remediation. Stage 1 specifies the decision making process, identifies why additional data are needed, and sets the foundation for Stages 2 and 3 of the DQO development process.
2	Stage 2 specifies the data (quantity and quality) necessary to meet the objectives set in Stage 1. This stage stipulates the criteria for determining data adequacy. Stage 2 includes selection of the sampling approaches and the analytical options used for each site.
3	Stage 3 specifies how to assemble data collection components and develop data collection documentation. Methods were specified by which acceptable data will be obtained to make decisions. This information will be provided in the site-specific sampling plan.

1.3.4 Stages of DQOs

Stage 1 DQOs applicable to the RI/FS include the following:

- The Project Manager and Site Manager will be responsible for all decisions regarding actions taken to respond to field data. They are also responsible for determining personal protection levels, for example, in response to site monitoring readings by field personnel. In all cases, the health and safety of field personnel will be protected.

- The Site Manager will be responsible for ensuring that the calibration of field instruments is checked and adjusted as necessary before use each day according to manufacturers' instructions. All calibration actions will be recorded in the field log in indelible ink.

- Field-screening measurements will be used to initially characterize each site during drilling and sampling activities. If field-screening measurements identify local areas of elevated contamination, the field sampling plan may be modified by the Project Manager upon approval by the Air National Guard (ANG) Project Manager, in order to accurately assess the contamination.

Stage 2 DQOs applicable to the RI/FS include the following:

- The field geologist will be responsible for ensuring that the required volume of each sample matrix is collected to ensure that complete laboratory analysis objectives are met.

- The field geologist is responsible for ensuring that all QA/QC samples are collected in accordance with the field sampling plan and this QAPP.

- Personnel exposure to airborne contaminants will not exceed applicable Threshold Limit Values. Sites will be continuously screened to ensure that field personnel are not exposed to contaminants that would be harmful to their health and safety.

- Samples will be strictly controlled in accordance with ANG site investigation protocol. Samples will be collected using only decontaminated equipment. The Site Manager will be responsible for ensuring that ANG protocols for decontamination and sampling are met. In accordance with the field sampling plan, care will be taken to eliminate cross-contamination during sampling activities.

Stage 3 DQOs applicable to the RI/FS include the following:

- Documentation is key to ensuring that the highest levels of accuracy, precision, completeness, representativeness, and comparability are met. Accordingly, all field personnel will be trained and familiar with standard documentation requirements. Training will include

KCSlip4 41626

SEA408156

information on how analytical data will be used for site investigation decisions.

- The Work Plan will be approved by the ANG prior to implementation and will include complete matrix and QA/QC sampling requirements.
- All field notes taken during sampling activities will be recorded in field log books using indelible ink.
- Samples will be labeled using a standard sample label, with all required data elements included.
- Sample data will be entered on the Chain-of-Custody Record to ensure proper sample tracking and control.
- Samples will be shipped in sealed containers and accompanied by the Chain-of-Custody Record.
- QA/QC samples, including trip blanks, equipment blanks, field duplicates, and matrix spike/matrix spike duplicates will be collected, controlled, and shipped in the same manner as normal field samples, to ensure that field collection protocols will produce accurate site data and that laboratory analytical procedures meet the highest standards of performance.
- Complete and traceable Chain-of-Custody Records will be maintained to document that proper sampling and QA/QC protocols were observed in data collection and analysis. Only traceable data will be used for decision-making regarding further sampling requirements, site remediation, or site closure.

1.4 Quality Assurance Objectives for Measurement Data

The overall QA objective is to develop and implement procedures that will ensure quality in field sampling, field testing, chain-of-custody, laboratory analysis, data analysis, and data reporting. Specific procedures for sampling, chain-of-custody, audits, preventive maintenance, and corrective actions are described in other sections of this QAPP. This section defines the numeric quantitation and QC limits for ensuring that analytical data of appropriate accuracy and precision are obtained. QC during field sampling is also discussed.

1.4.1 Regulatory Parameters

Analysis of soil and groundwater samples collected during the Phase II RI/FS will be performed in accordance with analytical procedures that conform to United States Environmental Protection Agency (USEPA) guidelines published in *Test Methods for Evaluating Solid Wastes (SW-846), Third Edition* (update package, December 1997).

Washington State soil and groundwater cleanup levels for volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) (the constituents of interest during the Phase II RI) are presented on Table B-2. Soil and groundwater cleanup levels will be recalculated as necessary for the Phase II RI/FS report to account for changes in federal Maximum Contaminant Levels (MCLs) and/or toxicological data as published in Model Toxics Control Act (MTCA) risk calculation updates. The practical quantitation limits for some of the constituents listed on Table B-2 are higher than the MTCA method B cleanup levels. The Washington State Department of Ecology (WDOE) recognizes this situation and provides guidance regarding adopting practical quantitation limits as cleanup levels (WDOE, 1995).

Tables B-3 and B-4 summarize the quantitation limits for VOCs analyzed by USEPA Methods 8260 and 8010/8020. Maximum quantitation limits for TPH in soil and groundwater are 30 milligrams per kilogram (mg/kg) and 1 milligram per liter (mg/l), respectively. Required holding times for soil and water samples are summarized on Table B-5.

1.4.2 Sampling Plan for Phase II Remedial Investigation

The sampling plan for the Phase II RI is summarized in the main text of the Phase II RI/FS Work Plan.

1.4.3 Quality Control During Field Sampling

Field duplicate samples and equipment rinsate blanks, field blanks, and trip blanks will be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Rinsate, field, and trip blanks will be analyzed to check for contamination associated with sampling procedures and/or ambient conditions at the site. Duplicate samples will be submitted using nonindicative sample identifiers to provide a QA check on analytical procedures and results.

KCSlip4 41628

SEA408158

TABLE B-2

Washington Soil and Groundwater Cleanup Levels for VOCs and TPH
143rd CCSQ, Seattle ANGS, Seattle, Washington

	GROUNDWATER Concentration in µg/l				SOIL Concentration in mg/kg	
ANALYTICAL GROUP	Primary MCL	Secondary MCL	MTCA - Method A	MTCA - Method B	MTCA - Method A Residential/Industrial	MTCA - Method B
VOLATILE ORGANIC COMPOUNDS (VOCs)						
Benzene	5	–	5.0	**1.5**	0.5 / 0.5	34.5
Bromodichloromethane	100*	–	–	**0.7**	–	16.1
Bromoform	100*	–	–	5.5	–	127
Bromomethane	–	–	–	11.2	–	112
Carbon disulfide	–	–	–	800	–	8,000
Carbon tetrachloride	5	–	–	**0.33**	–	7.7
Chloroform	100*	–	–	7.17	–	164
Chlorobenzene	100	–	–	160	–	1,600
Ethylbenzene	700	–	30	800	20 / 20	8,000
Methylene chloride	5	–	5	–	0.5 / 0.5	–
Toluene	1,000	–	40	1600	40 / 40	16,000
Trichloroethylene	5	–	5	**3.98**	0.5 / 0.5	90.9
Tetrachloroethylene	5	–	5	**0.86**	0.5 / 0.5	19.6
Trihalomethanes (total)	100*	–	–	–	–	–
1,2-Dichloroethane	5	–	5	**0.48**	–	11
cis-1,2-Dichloroethylene	70	–	–	80	–	800
trans-1,2-Dichloroethylene	100	–	–	160	–	16,000
1,1-Dichloroethylene	7	–	–	**0.07**	–	1.67
Styrene	100	–	–	**1.46**	–	33.3
1,2-Dichloropropane	5	–	–	**0.64**	–	14.7
1,1,2,2-Tetrachloroethane	–	–	–	**1.68**	–	38.5
1,1,1-Trichloroethane	200	–	200	7200	20 / 20	72,000
Vinyl Chloride	2	–	0.2	**0.02**	–	0.53
1,1,2-Trichloroethane	5	–	–	**0.77**	–	17.5
Xylenes (total)	10,000	–	20	16,000	20 / 20	160,000
Monochlorobenzene	100	–	–	–	–	–
1,3-Dichlorobenzene	75	–	–	–	–	–
1,4-Dichlorobenzene	600	–	–	**1.8**	–	41.7
TOTAL PETROLEUM HYDROCARBONS (TPH)						
TPH as gasoline	–	–	1,000	(a)	100 / 100	(a)
TPH as diesel	–	–	1,000	(a)	200 / 200	(a)
TPH (other)	–	–	1,000	(a)	200 / 200	(a)

Sources: WDOE, 1993 and 1994
µg/l = micrograms per liter
mg/kg = milligrams per kilogram
-- = Not available
MCL = Federal Maximum Contaminant Level
* MCL for total trihalomethanes including bromoform, bromodichloromethane, chloroform, and dibromochloromethane
MTCA = Model Toxics Control Act
VOCs = Volatile organic compounds
TPH = Total petroleum hydrocarbons
PQL = Practical quantitation limit
Bold typeface/shading = PQL is greater than cleanup standard
(a) = Site-specific method B cleanup levels are calculated based on *Interim Interpretive and Policy Statement - Cleanup of Total Petroleum Hydrocarbons* (WDOE, 1997)

TABLE B-3

Accuracy, Precision, and PQL Limits for Method 8260
143rd CCSQ, Seattle ANGS, Seattle, Washington

	Soil			Groundwater		
	PQL	QC Limits (a)		PQL	QC Limits (a)	
Target Analyte	µg/kg	% Recovery	RPD	µg/l	% Recovery	RPD
Chloromethane	5			5		
Vinyl Chloride	5			5		
Bromomethane	5			5		
Chloroethane	5			5		
Trichlorofluoromethane	5			5		
Acetone	10			10		
2-Chloroethyl vinyl ether	20			20		
1,1-Dichloroethylene	5	59 - 172	22	5	64 - 124	14
Methylene Chloride	5			5		
Carbon Disulfide	5			5		
Vinyl Acetate	10			10		
1,1-Dichloroethane	5			5		
2-Butanone	10			10		
trans-1,2-Dichloroethylene	5			5		
cis-1,2-Dichloroethylene	5			5		
Chloroform	5			5		
1,1,1-Trichloroethane	5			5		
Carbon Tetrachloride	5			5		
1,2-Dichloroethane	5			5		
Benzene	5	66 - 142	21	5	67 - 127	11
Trichloroethylene (TCE)	5	62 - 137	24	5	60 - 120	14
1,2-Dichloropropane	5			5		
Bromodichloromethane	5			5		
4-Methyl-2-pentanone	10			10		
2-Hexanone	10			10		
cis-1,3-Dichloropropene	5			5		
trans-1,3-Dichloropropene	5			5		
1,1,2-Trichloroethane	5			5		
Toluene	5	59 - 139	21	5	72 - 132	13
Dibromochloromethane	5			5		
Tetrachloroethylene (PCE)	5			5		
Chlorobenzene	5	60 - 133	21	5	68 - 128	13
Ethylbenzene	5			5		
m,p-Xylenes	5			5		
o-Xylene	5			5		
Styrene	5			5		
Bromoform	5			5		
1,1,2,2-Tetrachloroethane	5			5		
1,3-Dichlorobenzene	5			5		
1,4-Dichlorobenzene	5			5		
1,2-Dichlorobenzene	5			5		

PQL- Practical Quantitation Limit
QC - Quality Control
RPD - Relative Percent Difference
µg/kg - micrograms per kilogram
µg/l - micrograms per liter
(a) - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC limits apply to both matrix spike and laboratory control sample recoveries.

TABLE B-4

Accuracy, Precision, and PQL Limits for Methods 8010/8020
143rd CCSQ, Seattle ANGS, Seattle, Washington

Target Analyte	PQL µg/l	QC Limits (a) % Recovery	QC Limits (a) RPD
Dichlorodifuoromethane	5		
Chloromethane	5		
Bromomethane	5		
2-Chloroethylvinyl ether	10		
Vinyl Chloride	5		
Choloroethane	5		
Methylene Chloride	1		
Trichlorofluoromethane	5		
1,1-Dichloroethylene	1		
1,1-Dichloroethane	1		
trans-1,2-Dichloroethylene	1	20	75-125
Chloroform	1		
1,2-Dichloroethane	1	20	75-125
1,1,1-Trichloroethane	1	20	75-125
Carbon Tetrachloride	1		
Bromodichloromethane	1	20	75-125
1,2-Dichloropropane	1		
trans-1,3-Dichloropropene	1	20	75-125
Trichloroethylene	1		
Chlorodibromomethane	1		
1,1,2-Trichloroethane	1	20	75-125
cis-1,3-Dichloropropene	1	20	75-125
Bromoform	2	20	75-125
1,1,2,2-Tetrachloroethane	2		
Tetrachloroethylene (PCE)	2		
Chlorobenzene	2		
Benzene	1	20	75-125
Toluene	1	20	75-125
Ethylbenzene	1	20	75-125
p-Xylene	1		
m-Xylene	1		
o-Xylene	1		
1,2-Dichlorobenzene	5		
1,3-Dichlorobenzene	5		
1,4-Dichlorobenzene	5		

Note: Sample PQLs are matrix-dependent. The PQLs listed in the table are provided for guidance and may not always be achieveable.
PQL- Practical Quantitation Limit
QC - Quality Control
RPD - Relative Percent Difference
µg/l - micrograms per liter
(a) - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC limits apply to both matrix spike and laboratory control sample recoveries.

KCSlip4 41631

SEA408161

TABLE B-5

Summary of Sample Holding Times for Water and Soil Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Parameter	Holding Time
	Water Samples
VOCs	Analyze within 14 days of collection.
TPH	Extract within 14 days of collection and analyze within 40 days of extraction.
	Soil Samples
VOCs	Analyze within 14 days of collection.
TPH	Extract within 7 days of collection and analyze within 40 days of extraction.

VOCs = Volatile organic compounds
TPH = Total petroleum hydrocarbons

QC for soil sample collection will include the following:

- Field duplicate samples and equipment rinsate blanks and field blanks will be collected at a frequency of 10 percent of the total number of original samples.
- One trip blank for VOC analysis will be included with each ice chest containing samples for VOC analysis. The trip blank will be prepared using ASTM Type II reagent grade water (or equivalent).

QC for groundwater sample collection will include the following:

- Field duplicate samples and equipment rinsate blanks and field blanks will be collected at a total frequency of 10 percent of the total number of original samples.
- One trip blank for VOC analysis will be included with each ice chest containing samples for VOC analysis. The trip blank will be prepared using ASTM Type II water (or equivalent).

Matrix spike samples provide information about the effect of the sample matrix on the analytical methodology. Matrix spike analyses are performed in the analytical laboratory. All matrix spikes are performed in duplicate. Samples designated as matrix spike/matrix spike duplicate samples are investigative samples collected at triple the volume for VOCs and double the volume for the remaining analytes. One matrix spike/matrix spike duplicate will be designated for every 20 samples per sample matrix (water and soil matrices).

QC for field measurements (e.g., pH, specific conductance, and turbidity) consists of a pre-measurement calibration and a post-measurement verification using standard reference solutions in accordance with the manufacturer's recommendations. These procedures will be performed at least once per day or more often as necessary. QC for field measurement of temperature will include measurement with a second measuring device.

Holding times for water and soil samples are summarized on Table B-5. Holding times are defined as the maximum length of time that samples may be held before the completion of analytical protocols. All samples will be chilled in a temperature range between 2° and 4° C and will be maintained at that temperature through transport and subsequent storage at the analytical laboratory. Samples will not be retained on site over 24 hours unless prior approval is received from the ANG Project Manager.

1.4.3.1 Groundwater Sample Preservation

Samples collected for VOC analysis will be preserved with no more than two drops of a 1:1 solution of hydrochloric acid per 40-milliliter glass VOC vial. The vial will have a Teflon-lined septa within the lid. VOC samples will be stored in an ice chest.

1.4.3.2 Soil Sample Preservation

Soil samples submitted for laboratory analysis will be contained in brass sample tubes. Immediately upon removal from the drive sampler or hand auger, the ends of the filled brass tubes will be covered first with Teflon (a moisture barrier), aluminum foil, and then with a fitted plastic cap. Samples will then be placed in individual, self-sealing bags and stored in an ice chest with enough ice to maintain samples at a temperature of less than 4° C.

1.5 Accuracy, Precision, and Sensitivity of Analyses

The accuracy, precision, and sensitivity of laboratory analytical data must satisfy the QC acceptance criteria of the analytical protocols. Quantitation and QC limits required for aqueous and solid matrices analyzed per USEPA protocols are shown on Tables B-3 and B-4.

1.5.1 Quality Assurance Objective for Accuracy

Analytical accuracy is calculated by expressing, as a percentage, the recovery of an analyte that has been added to the sample (or standard matrix) at a known concentration before analysis and is expressed in the following formula:

$$\text{Percent Recovery} = \frac{(SSR-SR)}{SA} \times 100$$

Where

SSR = Spiked Sample Result;
SR = Sample Result; and

KCSlip4 41634

SEA408164

SA = Spike Added.

The spiked concentration will be specified by laboratory QC requirements or may be determined relative to the background concentrations observed in the nonspiked sample. In the latter case, the spiked concentration should be significantly higher (two to five times higher) than the background concentration to permit a reliable recovery calculation.

For volatile organic analysis by gas chromatography (GC) and GC/mass spectrometry, analytical accuracy is obtained from the surrogate recovery measured in each sample and blank or from the analysis of samples or blanks spiked with a select number of target analytes.

The QA objectives for surrogate recovery are summarized on Table B-6. The QA objectives for matrix spike recovery are summarized on Tables B-3 and B-4. Failure to achieve these recoveries will trigger corrective action. The recovery values for surrogate and target analytes in field sample analyses are advisory for routine laboratory analytical services.

1.5.2 Quality Assurance Objective for Precision

Analytical precision is calculated by expressing, as a percentage, the difference between the results of analysis of duplicate samples relative to the average of those results for a given analyte. Precision can be expressed by the following formula:

$$RPD = \frac{(SPL1 - SPL2)}{\text{Mean of SPL1 and SPL2}} \times 100$$

Where

RPD = Relative Percent Difference;

SPL1 = First sample value (original); and

SPL2 = Second sample value (duplicate).

The QA objectives for analytical precision are summarized on Tables B-3 and B-4. Failure to achieve these objectives will trigger corrective action.

1.5.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the relative number of analytical data points that meet all the acceptance criteria for accuracy, precision, and any other

TABLE B-6

Quality Assurance Objectives for Accuracy of Surrogate Spike Samples 143rd CCSQ, Seattle ANGS, Seattle, Washington

Compound/Method	Surrogate Compound	Water Percent Recovery Limits	Low/Medium Soil Percent Recovery Limits
VOCs/8260	Bromofluorobenzene	86-115	74-121
VOCs/8260	1,2-Dichloroethane-d	76-114	70-121
VOCs/8260	Toluene-d8	88-110	81-117

VOCs = Volatile organic compounds
Note: These limits are for advisory purposes only. They are not used to determine whether a sample should be reanalyzed.

KCSlip4 41636

SEA408166

criteria required by the specific analytical methods used. The percent of completeness for analytical data can be expressed by the following formula:

Percent Completeness = (V/T) x 100

Where

V	=	Number of valid data points; and
T	=	Total number of data points.

The QA objective for analytical data completeness for the RI/FS is 90 percent. The ability to meet or exceed this objective depends on the nature of the samples submitted for analysis.

The sampling plan has been designed to provide data representative of site conditions. During development of the sampling methodologies, consideration was given to past waste disposal practices, existing analytical data, physical setting, and constraints inherent to the program.

The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to collect data for the Phase II RI, as documented in this QAPP, are expected to provide analytical data that are comparable to the Phase I RI data. However, the data collected during the Phase I and II RI may not be directly comparable to previous data collected at the site because of possible differences in the sampling and/or analytical procedures and QA objectives.

1.6 Field Measurements

Most data collected during the RI/FS will be based on laboratory analysis of samples collected at the investigation site. There are certain data, such as groundwater parameters (i.e., specific conductance, temperature, turbidity, and pH) that will be collected and directly recorded in the field. The primary QA objectives for field activities should verify that QC checks are performed, measurements are obtained to the degree of accuracy consistent with their intended use, and documentation is generated to verify adherence to required measurement procedures.

Surveying and mapping at the Seattle ANGS will be conducted to provide a common frame of reference for RI/FS activities. Surveying will be performed by a surveyor registered in the State of Washington. Surveying of monitoring wells and soil borings will be completed to an accuracy of ± 0.1 foot horizontally and ± 0.01 foot vertically. Bench marks used during the survey will be permanent marker(s) that will be tied to National Geodetic Vertical Datum (NGVD) Mean Sea Level using either U.S. Coast and Geodetic Survey or U.S. Geological Survey monuments.

The recording of field data will follow standard reporting procedures as follows:

- Soil sampling depths will be reported to the nearest 0.1 foot.
- All temperatures will be recorded to the nearest 0.1° C
- pH will be reported to 0.1 standard units.
- Depth to groundwater in monitoring wells will be reported to the nearest 0.01 foot.
- Photoionization detector (PID) measurements will be reported in parts per million (ppm) and will be reported with the maximum precision attainable in the instrument range scale used for the measurement
- Specific conductance will be reported in microsiemens and will be reported with the maximum precision attainable in the instrument range scale used for the measurement.
- Turbidity will be reported in nephelometric turbidity units and will be reported with the maximum precision attainable in the instrument range scale used for the measurement.

1.7 Sampling Procedures

Procedures used for collecting environmental samples will follow standard operating procedures (SOPs) developed for Environmental Resources Management's (ERM's) Installation Restoration Program (IRP) work and will conform to ANG site investigation protocol. The SOPs are included in Appendix B of ERM's IRP Program Quality Assurance Program Plan (ERM, 1995). The Site Manager is responsible for ensuring that samples are collected with properly decontaminated equipment and contained in proper sample containers with appropriate preservatives. The steps required for sample control and identification, data recording,

KCSlip4 41638

SEA408168

and chain-of-custody documentation are included in the IRP Quality Assurance Program Plan.

Prior to the beginning of each sampling event, the Project Manager will meet with the assigned sampling personnel and review the purpose and objectives of the sampling. This meeting will provide final clarification of the sampling event details. Topics of review and discussion will include the following: sampling locations; types of samples to be collected; number of samples to be collected; sample identifiers; constituents to be analyzed; sampling procedures; sampling equipment decontamination procedures; and chain-of-custody documentation requirements.

Equipment decontamination is an integral part of the data collection and QA process. The implementation of proper decontamination practices and procedures will begin in the field prior to the use of sample collection equipment. All field sampling equipment will be decontaminated before and after use, in accordance with ANG protocols. Wash water and other fluids created during decontamination will be containerized and will be disposed of properly.

1.7.1 Soil Sampling

Subsurface soil samples will be collected using a hollow-stem auger or Geoprobe drill rig equipped with a split-spoon (or equivalent) drive sampler. The drive sampler will be constructed of stainless steel and lined with brass sample tubes. Augers, drill rods, the drill rig, and other drilling equipment will be decontaminated before each new soil boring. The drive sampler will be decontaminated before each new soil sample. Equipment decontamination procedures are detailed in the Phase II RI/FS Work Plan.

1.7.2 Groundwater Sampling

The following procedures will be used during groundwater sampling activities at monitoring wells:

- Immediately prior to collecting a sample, the static water level will be measured with reference to the monitoring well's measuring point and will be recorded in the field notebook.
- Whenever feasible, monitoring wells will be sampled in order of increasing concentration of contaminants, based on analysis of samples collected during previous sampling events.

KCSlip4 41639

SEA408169

- Prior to collecting a sample, water in the well casing will be purged at a rate of less than 1 liter per minute using a non-dedicated submersible sampling pump. The temperature, pH, specific conductance, and turbidity of the purge water will be monitored during well purging using an in-line flow cell and portable water quality test meter. The purging will continue until the temperature, pH, specific conductance, and turbidity of the purge water have stabilized to within ± 10 percent. The amount of water purged from each well will be measured and recorded.

- Monitoring wells will be sampled directly from the pump discharge or with a disposable polyethylene sampling bailer. The pump discharge hose will be thoroughly decontaminated before each well is sampled.

- Sampling equipment will be kept off of potentially contaminated surfaces to prevent cross-contamination of the samples (e.g., equipment will be placed on plastic sheeting).

- The calibration of the portable water quality test meter used to monitor field parameters during well purging will be checked and adjusted as necessary according to manufacturer's recommendations, at the beginning of each day and periodically during the day as required.

1.8 Sample Chain-of-Custody Procedures

Sample chain-of-custody procedures require that possession and handling of all samples be documented from the moment of its collection through the time of completion of laboratory analyses. The Chain-of-Custody Record must clearly reflect the movement of the sample through the sample handling and transport process to ensure that proper custody has been maintained and that the sample has not been tampered with in any way. A sample is judged to be in proper custody when at least one of the following criteria has been met:

- The sample is in one's actual physical possession;

- The sample is in one's clear field of view after being in one's physical possession;

- The sample is in one's physical possession and is then locked up in a secure container so that no one can tamper with it; or

- The sample is kept in a secured area that can be accessed by authorized personnel only.

1.8.1 Sample Labels

All samples will be identified with a label or permanent marker applied directly to the container. Sample identification information will be completed using waterproof ink and will consist of the following:

- Unique sample identifier;
- Time and date of collection;
- Site name;
- Preservative (if any); and
- Sampler's initials.

1.8.2 Chain-of-Custody Record

To maintain a record of sample collection, transfer between sample custodians, shipment, and receipt by the laboratory, a Chain-of-Custody Record will be filled out for all samples collected for laboratory analysis. Each time the samples are transferred, the signatures of the person relinquishing and receiving the samples, as well as the date and time of transfer, will be documented on the Chain-of-Custody Record.

1.8.3 Transfer of Custody and Shipment

Prior to the shipment of samples, the Chain-of-Custody Record will be signed and dated by a member of the field team who has verified that those samples indicated on the Chain-of-Custody Record are indeed being shipped. A copy of ERM's standard Chain-of-Custody Record is shown on Figure B-1. After packaging has been completed and the samples are closed within the ice chest, signed and dated custody seals will be placed over the edge of the ice chest lid.

Samples will be shipped by air or ground courier, or hand delivered by ERM personnel to the analytical laboratory. Samples will be transported, generally each day, by field personnel from the Station to the courier location for subsequent shipment to the laboratory. Upon receipt of the samples at the laboratory, the receiver will complete the transfer by dating

Enviromental Resources Management

CHAIN OF CUSTODY RECORD

NO:

915 - 118th Ave. S.E., Suite 130 • Bellevue, WA • 98005 • (425) 462-8591 • FAX (425) 455-3573

Page ______ of ______

PROJECT #	PROJECT NAME

SAMPLER: (PRINT NAME)	(SIGNATURE)

RECEIVING LABORATORY

OF CONTAINERS

MATRIX: SOIL | WATER | GAS

REQUESTED PARAMETERS

SAMPLE I.D.	DATE	TIME	COMP	GRAB	SAMPLING METHOD	PRESER-VATIVE	ICE (Y/N)	SAMPLING VOLUME

RELINQUISHED BY *(SIGNATURE)*	DATE	TIME	RECEIVED BY	DATE	TIME
RELINQUISHED BY *(SIGNATURE)*	DATE	TIME	RECEIVED BY	DATE	TIME
RELINQUISHED BY *(SIGNATURE)*	DATE	TIME	RECEIVED BY	DATE	TIME

FIELD REMARKS

REMARKS ON SAMPLE RECEIPT

☐ BOTTLE INTACT ☐ CUSTODY SEALS ☐ CHILLED
☐ PRESERVED ☐ SEALS INTACT ☐ SEE REMARKS

ERM REMARKS

SEND REPORT TO:

WHITE - LABORATORY COPY CANARY - FIELD COPY PINK - DATABASE MANAGER GOLD - PROJECT FILE

FIGURE B-1

Chain-of-Custody Record

143rd Combat Communications Squadron, Seattle ANGB, Seattle, Washington

KCSlip4 41642

SEA408172

and signing the Chain-of-Custody Record. An acceptable alternative is to enter the airbill number and shipping data into the appropriate signature/date block.

A copy of the airbill is to be kept with the field copy of the Chain-of-Custody Record to document specific shipping information.

1.8.4 Laboratory Chain-of-Custody Procedures

The following describes laboratory chain-of-custody procedures associated with sample receipt, storage, preparation, analysis, and general security.

1.8.4.1 Sample Receipt

Sample receipt procedures are discussed below.

- Upon receipt, the sample custodian will inspect sample containers for integrity. The presence of leaking or broken containers will be noted on the Chain-of-Custody Record. The sample custodian will sign the Chain-of-Custody Record with the date and time of receipt, thus assuming custody of the samples.

- The information on the Chain-of-Custody Record will be compared with the information on the sample labels to verify the exact sample identity. Any inconsistencies will be immediately resolved with the field sampling representative before sample analysis proceeds.

- Samples will be moved to a locked sample storage refrigerator for storage prior to analysis. The storage location will be recorded on the Chain-of-Custody Record or Laboratory Tracking Form to ensure continuity of sample tracking.

- The sample custodian will retain the original Chain-of-Custody Record and will provide copies to each laboratory section manager and one to the laboratory's sample master log.

- The sample custodian will alert the appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

1.8.4.2 Sample Storage

Samples requiring refrigeration will be maintained in a locked storage refrigerator which will be kept at a temperature ranging from 2° to 4° C. Analytical laboratory personnel will request samples for analysis from the sample custodian and the formal transfer action, including date and signatures, will be recorded on the Chain-of-Custody Record. The analyst will then be the custodian of the sample during analysis.

1.8.4.3 Data Recording

Raw data is calculated or reduced into reportable values in three ways at the laboratory: manually, by an external computer program, and by a data system that collects the raw data. Individual laboratories have specific data recording and data management standard operating procedures. In general, data collected on an instrument's data system are transferred electronically into the laboratory's data acquisition program. Data acquisition transfers data into the laboratory information management system for routine final reporting and is also used for generation of analytical data reports. All formulae used to calculate reported values are those specified by the analytical method and are included in internal laboratory standard operating procedures.

1.9 Documentation Procedures

Documentation procedures for sample identification and field logs are discussed below. Procedures for document corrections are also discussed.

1.9.1 Sample Identification

A standardized numbering system will be used to identify soil and groundwater samples collected during RI/FS field activities. The numbering system provides a tracking procedure to ensure accurate data retrieval of all samples collected. A listing of the sample identification numbers will be maintained by the Site Manager, who will be responsible for ensuring the standardized numbering system is followed during sampling activities.

The standard sample identifiers for field samples are coded as follows:

- Sample identifiers for primary soil samples will include the soil boring number and sample depth. For example, SB-1-5 represents a sample collected at a depth of 5 feet bgs from soil boring SB-1.

- Sample identifiers for primary groundwater samples will include the monitoring well number and the quarterly sampling round. For example, MW1-98-1 represents a groundwater sample collected during the first round of quarterly sampling in 1998 from monitoring well MW-1.

Field QA/QC sample identifiers for soil will be as follows:

- Sample identifiers for trip blanks will be as follows: TB-date-#. For example, TB-081098-1 represents the first trip blank collected on 10 August 1998.

- Sample identifiers for field duplicate samples will be the same as the original sample but followed by a "D."

- Sample identifiers for rinsate blanks and field blanks will consist of the soil boring identifier at which the blank was prepared followed by an "R" for rinsate blanks, an "FT" for tap water field blanks, or an "FA" for ASTM Type II water field blanks.

Field QA/QC sample identifiers for groundwater will be as follows:

- Sample identifiers for trip blanks will be the same as those for soil.

- Sample identifiers for field duplicate samples will be the same as the original sample but followed by a "D."

- Sample identifiers for rinsate blanks and field blanks will consist of the monitoring well identifier at which the blank was prepared followed by an "R" for rinsate blanks, an "FT" for tap water field blanks, or an "FA" for ASTM Type II water field blanks.

1.9.2 Field Logs

Data collection activities performed at the site will be documented in bound field notebooks and on Chain-of-Custody Records using indelible ink. Field notebooks will be assigned to individual field personnel for the

KCSlip4 41645

SEA408175

duration of their field activities. Entries will be as detailed and descriptive as possible so that a particular situation can be recalled without reliance solely on the sampler's memory. All field log entries will be dated and signed by the person making them.

Depending on field activities, the Site Manager may designate a member of the field team to photocopy, at the end of each day, all field notes (notebook pages and standard forms) generated during that day. Copies will be given to the Project Manager. If implemented, at the completion of a work shift, copies of all field logs, notebook pages, and standard forms will be returned to the Site Manager for subsequent delivery to the Project Manager and entry into project files.

The Site Manager will maintain a separate Site Log summarizing daily field activities, outside visitors, communications, sample shipments, and equipment assignments. This log will become a part of the original project files.

1.9.3 Corrections to Documentation

If an incorrect entry is made in any type of data document, the incorrect entry will be crossed out with a single line, the correct information entered, and the correction initialed and dated by the person making the correction. Like original entries, corrections will be made in indelible ink.

1.9.4 Final Evidence File Documentation

Records will be kept in the project files to document QA/QC activities and to provide support for possible evidential proceedings. The following outline of project file requirements applies to project activities:

Communications

- Internal
- External
- QA/QC
- Procedures
- Chain-of-Custody Documentation

- Audit Reports
- Laboratory QA Reports
- Deviation Notification Forms
- Nonconformance/Corrective Action Reports

Technical Information

- Analytical Data
- Field Data
- Field Logbooks
- Graphic Resources
- Data Quality Acceptance
- Calculations/Evaluations
- Regulatory Compliance

Project Management

- Project Schedule
- Budget
- Site Database Information

Health and Safety

- Plans/Procedures
- Audit Reports

Documents

- Plans
- Reports
- Relevant Publications

KCSlip4 41647

SEA408177

ERM will maintain all evidential file documentation using its internal project file system. Upon completion of the project, the original project files will be archived. Copies of file documentation will be provided to the ANG upon request. The Project Manager will ensure that all records, including QA/QC records, are properly stored and retrievable.

1.10 Calibration Procedures and Frequency

The following sections summarize calibration procedures for field and laboratory equipment.

1.10.1 Field Equipment

The analytical and health and safety screening instruments that may be used in the field during the Phase II RI/FS are:

- PID;
- Conductivity Meter;
- pH Meter;
- Turbidity Meter; and
- Temperature Meter.

The instruments will be calibrated according to manufacturers' specifications before and after each field use, or as otherwise required. Where necessary, instruments will be calibrated each day during field use.

1.10.1.1 Photoionization Detector

A calibration check of the PID will be performed at the start of each day using a standard calibration gas. Additional calibration checks and instrument adjustments will be made if the unit experiences abnormal perturbations or readings become erratic. Results of the calibration check will be recorded in the field notebook in indelible ink. Calibration procedures will follow manufacturer's instructions.

1.10.1.2 Conductivity Meter

Calibration will be performed at the start of each sampling day using a standard solution of potassium chloride. The meter will be adjusted to

KCSlip4 41648

SEA408178

read the value of the standard. The meter must read within 10 percent of the standard to be considered in control and should read within 5 percent (7 percent is considered a warning level). If the calibration indicates the meter readings are out of the control limits, a backup unit should be used. If a backup unit is not available, the data will be flagged to note the percent difference between the meter and the standard calibration solution. Readings from conductivity meters lacking calibration adjustments are normally stable; thus, calibration checks are usually limited to the beginning and end of the sampling day.

1.10.1.3 pH Meter

Calibration will be performed at the start of each sampling day using buffer solutions that bracket the pH range expected in the samples. The pH meter will be adjusted to read the value of the standard. The meter is checked during the sampling day, using at least one standard, at a frequency which results in little or no calibration adjustment. If the reading varies more than one-tenth of a pH unit between calibration checks, the frequency of the checks must be increased.

1.10.1.4 Turbidity Meter

Calibration will be performed at the start of each sampling day using a formazin solution. The turbidity meter will be adjusted to read the value of the standard. The meter is checked during the sampling day, using at least one standard, at a frequency which results in little or no calibration adjustment. If the reading varies more than one-tenth of a turbidity unit between calibration checks, the frequency of the checks must be increased.

1.10.1.5 Temperature Meter

Temperature will be measured by either using a thermostat built into the specific conductance meter or a separate thermometer unit. Temperature readings will be checked at least once per field trip using a quality-grade (preferably National Bureau of Standards traceable) thermometer. Should the unit experience erratic or out-of-tolerance readings, additional checks will be performed.

1.10.2 Laboratory Equipment

Before any laboratory instrument is used as a measuring device, the instrument response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. Sample measurements will be made within the calibrated range of the instrument.

Laboratory calibrations typically consist of two types, initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. Continuing calibration usually includes measurement of the instrument response to one or more calibration standards and requires instrument response to compare with certain limits (e.g., ± 10 percent) of the initial measured instrument response.

Specific laboratory instrument calibration procedures for various instruments are described in detail in the Laboratory Quality Assurance Project Plan for the analytical laboratory selected to perform the analyses.

1.11 Analytical Procedures

The following sections summarize the analytical procedures for field activities and the laboratory.

1.11.1 Field Parameters

As part of the analytical protocol for groundwater samples, several parameters will be tested in the field. Monitoring well purge water will be tested for specific conductance, temperature, pH, and turbidity. The field parameters will be measured using an in-line flow cell.

1.11.2 Laboratory Methods

Groundwater and soil samples collected will be analyzed using the analytical methods specified in the Phase II RI/FS Work Plan.

1.12 Internal QC Check Procedures

The following sections summarize internal QC check procedures for laboratory analysis and field measurements.

KCSlip4 41650

SEA408180

1.12.1 Routine Analytical Services

Internal QC procedures for routine analytical services are specified in the USEPA's method descriptions. These specifications include the types of QC checks required (sample spikes, surrogate spikes, reference samples, controls, and blanks), the frequency of each audit, the compounds to be used for sample and surrogate spikes, and QC acceptance criteria for these checks.

1.12.2 Field Measures

QC procedures for field measurements are linked to checking the reproducibility of the measurements by obtaining multiple readings and by calibrating the instruments (when appropriate). QC of field sampling will involve collecting field duplicates and blanks in accordance with the applicable procedures described in this QAPP.

1.13 Data Reduction, Validation, and Reporting

The following sections summarize reduction, validation, and reporting procedures for field, technical, and laboratory data.

1.13.1 Field and Technical Data

The field and technical (non-laboratory) data that will be collected can generally be characterized as either objective or subjective data. Objective data include all direct measurements, such as field screening/analytical parameters and water level measurements. Subjective data include activity descriptions and field observations.

1.13.1.1 Field and Technical Data Reduction

As described in previous sections, field data will be recorded by field personnel in bound field notebooks and on standard forms. For example, during drilling activities, the field team member supervising a rig will keep a chronological log of drilling activities, a vertical descriptive log of lithologies encountered, other pertinent drilling information (i.e., staining, odors, field-screening results, working conditions, and water levels) in his/her bound notebook. The Site Manager may choose to appoint a team member to photocopy all field logs (including notebook pages and standard forms) generated in a given field day. Copies will be given to the Site Manager who will maintain a field log file. At the direction of the Project Manager, copies of all field logs, notebook pages, and standard forms will be returned to the office for entry into project files.

After checking the validity of data in field notes and on standard forms, the Project Manager will be responsible for entering pertinent data into project data files. Where appropriate, the data files will be set up for direct input into the project database. Subjective data will be filed as hard copies for later review by the Project Manager and for incorporation into technical reports as appropriate.

1.13.1.2 Field and Technical Data Validation

Validation of objective field and technical data will be performed at two different levels. On the first level, data will be validated at the time of collection by following standard procedures and QC checks. At the second level, data will be validated by the Project Manager, who will review the data to ensure that the correct codes and units have been included. After data reduction into tabular format or the project database, the Project Manager will review data sets for anomalous values. Any inconsistencies or anomalies discovered will be resolved immediately, if possible, by seeking clarification from field personnel responsible for collecting the data.

Subjective field and technical data will be validated by the Program Manager, who will review field reports for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made by the Project Manager or Site Manager who will check recorded data at that time to confirm the recorded observations. Whenever possible, peer review will also be incorporated into the data validation process, particularly for subjective data, to maximize consistency among field personnel. For example, during drilling activities, the Project Manager or Site Manager will schedule periodic reviews of archived lithologic logs to ensure that proper lithologic descriptions and codes have been consistently applied by field personnel.

1.13.2 Laboratory Data

As described earlier, analytical data will be recorded in three ways: manually; an external computer program; and a data system that collects the raw data. Data collected on an instrument's data system are transferred electronically into the laboratory's data acquisition program. Data acquisition transfers data into the laboratory information

KCSlip4 41652

SEA408182

management system for routine final reporting and is also used for production of analytical data reports. Copies of strip-chart outputs (e.g., chromatograms) will be maintained on file at the laboratory.

1.13.2.1 Laboratory Data Reduction

At the completion of a set of analyses, all calculations will be completed and checked by the analyst. The associated QC data (blanks, blank spikes, duplicates) are entered onto QC charts and are verified to be within control limits. If all data are acceptable, the data are entered into the laboratory computer system, and data summaries (including raw data) are submitted to the laboratory section manager for review. This is the procedure for all analytical data. After approval, data are subsequently entered into the project database format.

1.13.2.2 Laboratory Data Validation

In addition to the data review performed by the analysts and the appropriate laboratory section manager, an external organization to the one that generated the data will validate the analytical data. Analytical data will be reviewed by the Project Manager and assessed by a qualified chemist, using a step-by-step approach. Approximately 10 percent of the data generated by the laboratory will be subjected to validation against DQOs using USEPA validation procedures for specified analytes.

Qualified data will be annotated in accordance with USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review, using the following codes:

U - The analyte was analyzed for, but was not detected above the associated value.
J - The associated numerical value is an estimated quantity.
R - The data are unusable. The presence or absence of the analyte cannot be verified from the existing data. Re-sampling and re-analysis is necessary for verification.
UJ - The analyte was analyzed for, but was not detected above the reported value. The associated value is an estimate.

In addition, the following data qualifiers may be used for organic data:

N - There is presumptive evidence to make a tentative identification.

NJ - There is presumptive evidence to make a tentative identification and the associated numerical value is an estimated quantity.

1.13.2.3 Laboratory Data Reporting

Laboratory analytical results will be reported as soon as results are available and will follow USEPA requirements in order to provide defensible evidence files. The standard laboratory data reports for organic compound analysis will consist of a transmittal letter and the following:

- A cover page describing data qualifiers, sample collection, extraction and analysis dates, and a description of any technical problems encountered with the analysis.
- Sample data including quantitation limits.
- Summary of QC data, including laboratory blanks, matrix spike/matrix spike duplicates, and surrogate recovery results.

The standard laboratory data reports for inorganic constituent analysis will consist of a transmittal letter and the following:

- A cover page describing data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analysis.
- Sample data including quantitation limits.
- Summary of QC data, including laboratory blanks, and matrix spike/matrix spike duplicate results.

1.14 Performance and System Audits

Audits may consist of two types: system and performance audits. The purpose of a system audit is to determine whether appropriate project systems are in place. Performance audits are used to indicate whether those systems are functioning properly. Audits will be conducted by the QA/QC Manager or a designated appointee as tasked by the Program or Project Manager, to verify the existence of an effective QA/QC system. Additionally, the audit will evaluate the level of compliance of that system in terms of adherence to QA/QC measures, standards, records, and project documentation and control.

1.14.1 Project System Audits

The QA/QC Manager may periodically, on an unannounced basis, call for a system audit. The Project Manager will respond by submitting the QAPP. The audit will be performed by the QA/QC Manager or a designated appointee. The auditor will then determine whether the QAPP is in place and whether the reviews called for by the QAPP have been performed. Results of project audits will be reported to the Project Manager and Program Manager.

1.14.2 Technical Performance Audits

Technical performance audits will be conducted by the project QA/QC Manager on an ongoing basis during the project, as field data are generated, reduced, and analyzed. All numerical analyses, including manual calculations, mapping, and computer support activities, will be documented and subject to performance audits in the form of QC procedural reviews, mathematical reanalysis, and peer review. Technical peer review is the responsibility of the Project Manager. All records of numerical analyses will be legible, reproduction quality, and complete enough to permit logical reconstruction by a qualified objective reviewer.

1.14.3 Field Audits

A field performance audit will be conducted during each phase of the investigation and will include field sampling and associated sample handling and decontamination techniques. The purpose of the field audit is to ensure that proper methods and protocols detailed in this QAPP are consistently practiced in the field.

Audits will be performed using tailored checklists prepared by the QA/QC Manager. The requirements and audit questions to be developed will be as specific as possible and will focus on significant investigation techniques. Checklists are encouraged to be completed to the maximum extent possible to give a complete picture of field techniques using a structured approach.

Field operation records will be reviewed to verify that field-related activities were performed in accordance with appropriate project procedures. Items reviewed will include, but are not limited to, field equipment calibration records, daily field logs, and chain-of-custody documentation.

KCSlip4 41655

SEA408185

Upon audit completion, an audit report containing observations, findings, and recommended corrective actions will be submitted to the Project Manager and the Program Manager.

1.14.4 Laboratory Audits

The laboratory QA manager has responsibility for monitoring the internal QA program. The contractor will verify that standardized QA programs are in effect to provide objective oversight of laboratory procedures. Additionally, copies of internal QA reports will be requested to ensure that standards of quality performance are in effect.

1.15 Preventive Maintenance

Proper preventive maintenance of field and laboratory equipment is an essential element in a successful field investigation. Implementation of standard preventive maintenance routines serves to eliminate surprise equipment failures and subsequent stand-by time.

1.15.1 Field Equipment

Field equipment will be properly calibrated, charged, and in good working condition before the beginning of each working day. Manufacturers' specifications define the required equipment checks for each type of field equipment used. Non-operational field equipment will be removed from service and a replacement will be provided immediately. Significant repairs to field equipment will not be performed in the field.

All field instruments will be properly protected during the field investigation against inclement weather. Each instrument is specially designed to maintain its operating integrity during variable temperature ranges that are representative ranges that will be encountered during working conditions. At the end of each working day, all field equipment will be taken out of the field and placed in a cool, dry room for overnight storage.

All subcontractor equipment (e.g., drill rigs) will arrive at the site in proper working condition each day. All lubricating and hydraulic motor oils will be checked by the subcontractor before the start of each work day to ensure all fluid reservoirs are full and there are no leaks. Before the

KCSlip4 41656

SEA408186

start of each work day, the Site Manager will also inspect subcontractor equipment for fluid leaks. If a leak is detected, the equipment will be removed from service for repair or replacement.

1.15.2 Laboratory Equipment

The ability to generate valid analytical data requires that all analytical instrumentation be properly maintained. The selected laboratory should maintain full service contracts on all major instruments. These service contracts will not only provide routine preventive maintenance, but will provide emergency repair service to ensure responsive support to the project requirements.

1.15.2.1 Instrument Maintenance Logbooks

Each analytical instrument is assigned a specific instrument logbook. All maintenance activities are recorded in the instrument log. The information entered in the instrument log will include the following:

- Date of service;
- Person performing service;
- Type of service performed and reason for service;
- Replacement parts installed (if appropriate); and
- Other information, as required.

1.16 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

The QA objectives for precision, accuracy, and completeness are discussed in Section 1.5. This section discusses the routine procedures used for assessing those criteria.

The initial responsibility to monitor the quality of an analytical system lies with the analyst. The analyst will verify that all QC procedures are followed and the results of analysis of QC samples are within acceptance criteria. If acceptance criteria limits are exceeded, this must be described in the analytical report case narrative. This requires that the analyst evaluate the results for the following laboratory QC items, as appropriate:

KCSlip4 41657

SEA408187

- Sample preparation procedures;
- Initial calibration;
- Calibration verification;
- Method blanks;
- Duplicate analyses;
- Laboratory control standards; and
- Spiked samples.

1.17 Corrective Action Protocols

The QA/QC Manager and audit team will prepare a formal report of any audit proceedings. The programmatic impact of a negative finding, such as failure to use an appropriate procedure, will be determined by the QA/QC Manager or lead auditor and reported to the project management staff. A corrective action plan and implementation schedule will be required, and the Project Manager will be responsible for ensuring that immediate action to correct the nonconformance has been initiated. The Project Manager will be responsible for ensuring the successful implementation of the corrective action plan and ensuring that no additional work that is dependent on the nonconforming action is performed until the nonconformance is corrected. Corrective actions may include reanalyzing samples (if holding times permit), resampling, and evaluating and amending sampling and analytical procedures.

The Project Manager will be responsible for ensuring that the corrective action adequately addresses the nonconformance. The QA/QC Manager will ensure that corrective actions for nonconformances are implemented by:

- Evaluating reported nonconformances;
- Controlling additional work on nonconforming items;
- Maintaining a log of nonconformances; and
- Ensuring that all Nonconformance and Corrective Action Reports are included in the project files.

KCSlip4 41658

SEA408188

Following implementation of satisfactory corrective action, the QA/QC Manager will conduct sufficient follow-up activities to verify the corrective action. Such confirmation will be documented, along with any other recommendations, in a formal close-out of the audit. The close-out report will be distributed to appropriate project management personnel.

1.17.1 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements and observations lies with field personnel. The Site Manager is responsible for verifying that all QC procedures are being followed in the field. This requires that the Site Manager assess the correctness of field methods and the ability to meet QA objectives. If a problem occurs that might jeopardize the integrity of the project or cause some specific QA objective not to be met, it is the responsibility of field project staff to report suspected nonconformances by initiating a Nonconformance and Corrective Action Report (Figure B-2) and submitting it to the Project Manager.

The Project Manager will submit a copy of the Nonconformance and Corrective Action Report to the QA/QC Manager for a formal investigation. An appropriate corrective action will then be developed and implemented.

1.17.2 Laboratory Corrective Action

If the analyst's assessment of the laboratory QC items identified in Section 1.16 reveals that any of the QC acceptance criteria have not been met, as defined by the Laboratory QAPP or USEPA method protocols, the analyst must immediately assess the analytical system to correct the problem. The analyst notifies his/her supervisor, section leader, or QA coordinator of the problem, and, if possible, identifies the potential cause(s) and makes appropriate corrective action recommendations.

The identification of the corrective action obviously depends on the nature of the problem. For example, if a continuing calibration verification is determined to be out of process control, the corrective action may require recalibration of the analytical system and reanalysis of all samples since the last acceptable continuing calibration standard.

Sample-related QC samples (e.g., matrix spikes and matrix spike duplicates) provide an indication of matrix effects on analyses and do not

Nonconformance and Corrective Action Report
Date: ___________
ERM-West Project Number: ____

SUBMITTAL

To: Project Director
QA/QC Officer

Description of Nonconformance and Cause:

____
____
____

Proposed Corrective Action:

____
____
____

Submitted By:____________________ Location:____________________
Approved By:____________________ Date: ____________________

CORRECTIVE ACTION (by Project Manager or Designee):

____
____
____

Implementation by Action assigned to:
Actual Corrective Action:
Implementation verbally approved by QA Officer on __________
(date)
Action implemented on __________
(date)

____
(Signature)

VERIFICATION (by QA/QC Officer of Designee)
Corrective Action implementation reviewed and Work Inspected by:

on__________

Corrective Action Verified by on________________

Figure B-2

Nonconformance and Corrective Action Report

KCSlip4 41660

SEA408190

require reanalysis if method-related QC samples (e.g., method blanks, method spikes, and method spike duplicates) indicate acceptable performance.

When the appropriate corrective action measures have been defined and implemented and the analytical system is determined to be in control, the analyst documents the problem, the corrective action, and the associated data, thereby demonstrating that the analytical system is in control. Copies of the documentation are provided to appropriate management staff members and the QA/QC Manager for review and addition to the project files.

1.18 QA Reports to Management

The ANG Project Manager will rely on written reports and memoranda documenting data assessment activities, quality audits, nonconformances, corrective actions, and quality notices. A copy of all significant QA reports will be forwarded to the Program Director for review and oversight.

KCSlip4 41661

SEA408191